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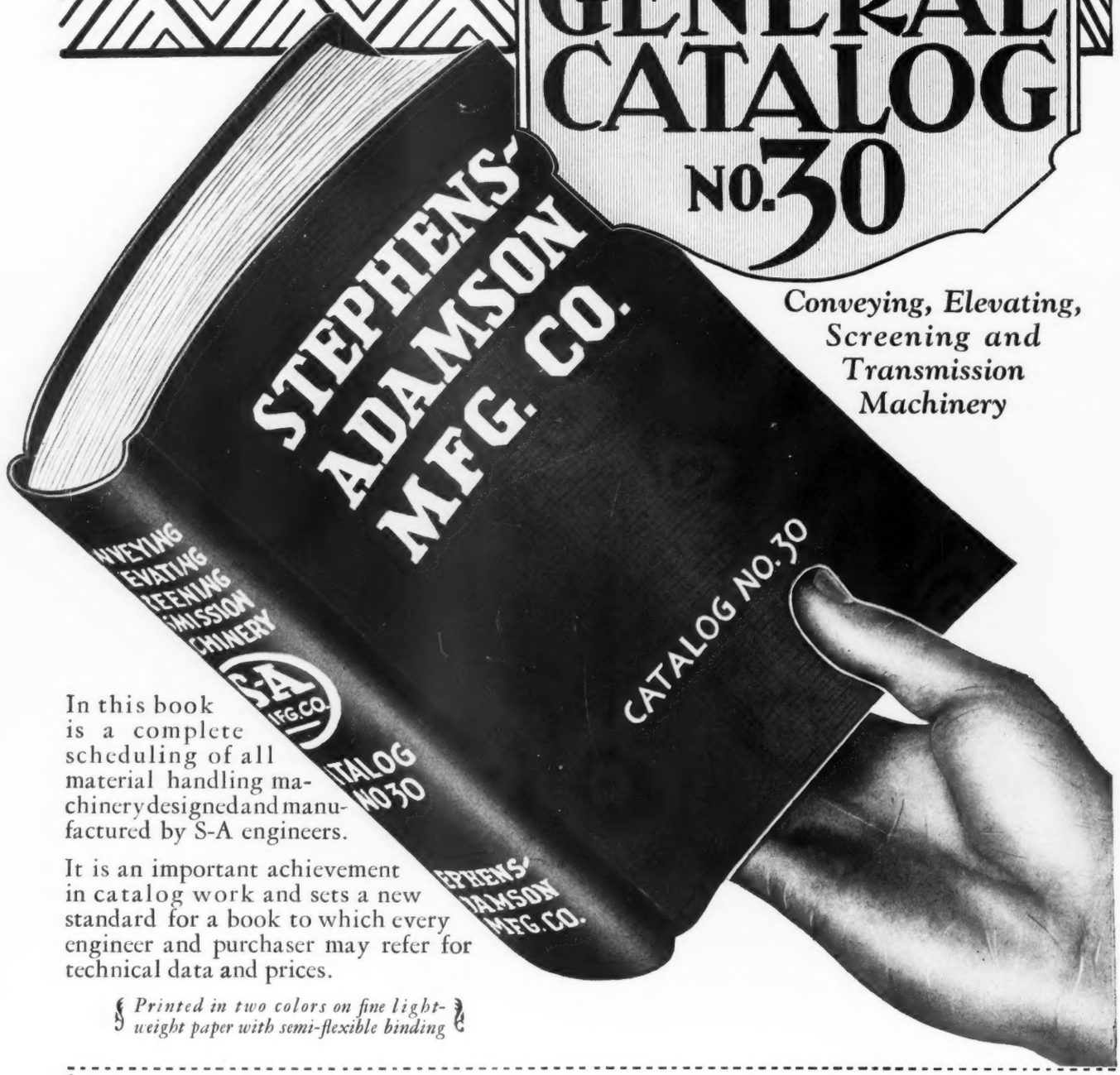

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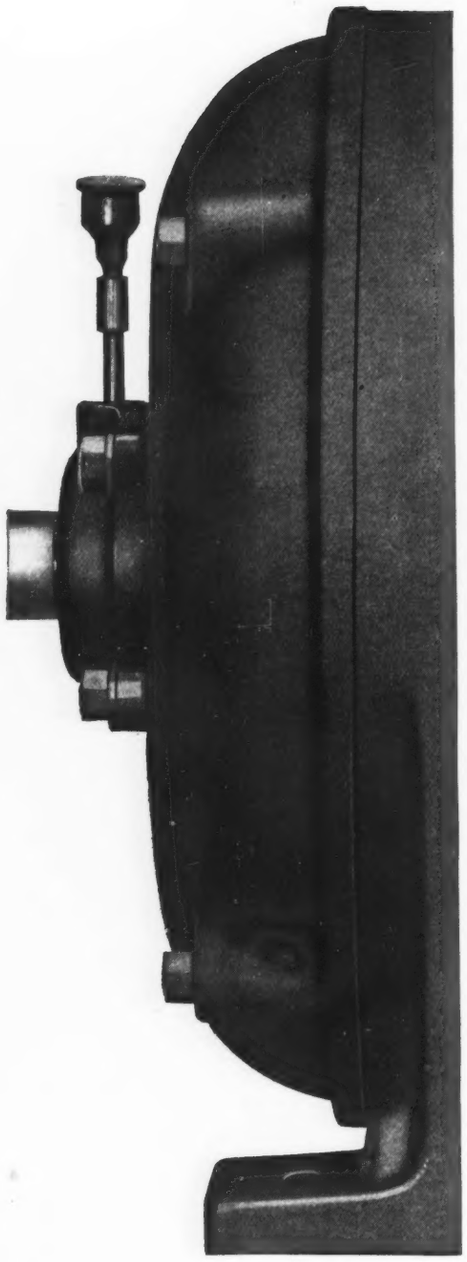

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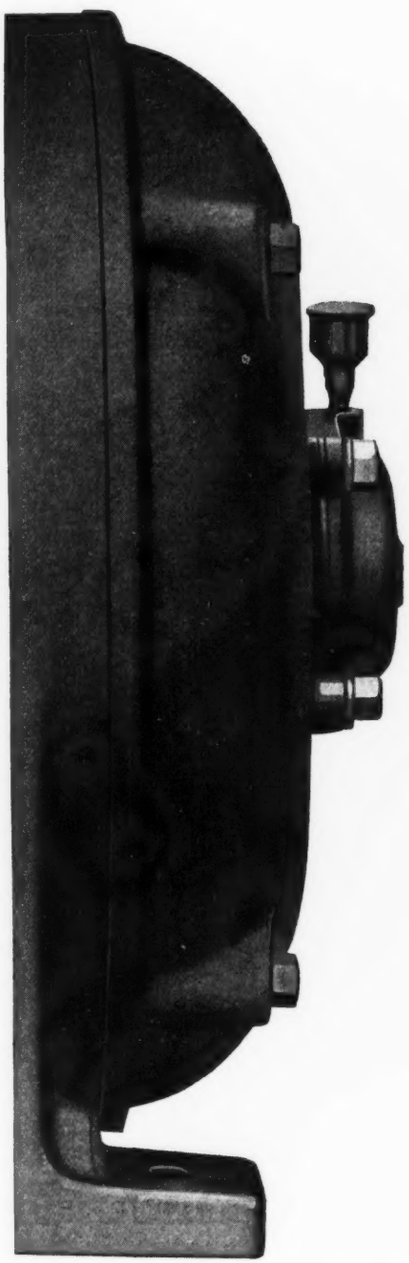

ALLIS-CHALMERS MOTORS

ENGINEERING AND
MINING JOURNAL

JOSIAH EDWARD SPURR, Editor

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A Prosperous Year

THE YEAR 1926 was a most prosperous year for the United States, to the immense self-complacency of the inhabitants, and to the acrimonious resentment of the pleasant nations of Europe. Yet one must blame neither the one nor the other. Put yourself in the other fellow's place. A tramp once threw a brick through the window of a private railroad car where we sat luxuriously at dinner, and we loved him for it. We have felt that way under different conditions ourselves.

Secretary Hoover and Secretary Mellon gave us facts and figures to show just how comfy we are—how full our larder and our savings banks are. That is all to the good, and Europe is coming along too—with her traditional international and intranational excitement and bickering.

Engineering and Mining Journal has shared in the general well-being which has characterized the mining industry as a whole. Evidences that the mining industry is satisfied with the *Journal* as its representative and spokesman are numerous. The standard statistical test of publishers, of a paper's stability and reader interest and satisfaction, is what is called the renewal percentage—that is the percentage of subscribers who renew their subscription. *Engineering and Mining Journal* has the highest mark in this respect of any paper in the house which publishes it: and the last report showed the highest percentage, for itself, for all time. As to material prosperity, we are pleased to report the best year since the present editorial administration began. We slide into the new year on the crest of the wave.

Survival of Guanajuato

AMONG the mining districts of Mexico, where, in recent years, most trouble has been experienced in making financial ends meet, is Guanajuato. The ores that remain in the old bonanza camp are for the most part low in grade, silver being the predominant metal. With silver valued at between 65 and 70c. per ounce, it represented about 82 per cent of the value, the remainder being gold. Operating costs have been comparatively high, particularly for underground mining; and high freight rates, high taxes, and labor difficulties have contributed their share to increasing the cost of production.

The decline in the price of silver below 55c. naturally precipitated a serious crisis in the district, and the shutting down of most of the mines was threatened. Recent reports, however, are to the effect that nearly, if not quite, all of the properties will be able to continue for the present at least. Some relief in the matter of production taxes probably will be finally put into effect by the government. The plan already has the sanction of both houses of the federal legislature and formal promulgation is expected at any time. Also, a reduction in wages of 10 per cent has been accepted by all employees.

Perhaps the most encouraging development in the situation, however, is that the labor unions and leaders apparently have adopted a saner attitude with respect to the over-manning of operations. It has long been the contention of mine managers in most of the districts of Mexico, that but for unreasonable regulations they could eliminate a good proportion of their workers without imposing any greater tasks on those that would remain. They argued that efficient organization of their forces would accomplish this end and reduce the costs of production. It is understood on good authority that the unions at Guanajuato have agreed to modify many of these burdensome regulations, and that this has contributed largely to the greater efficiency that will permit the continuance of production without the incurrence of large deficits. If the collapse of silver is the means of convincing the labor leaders that fewer workers, properly organized and equipped, can accomplish as much as many more who have not this organization and equipment, further proof will be advanced as to the validity of the old saw about an ill wind.

Platinum Mining in Africa

THE UNPRECEDENTED DISCOVERIES of lode platinum in Southern Africa a year or so ago naturally created great activity and excitement in mining circles. Platinum, except in placers, was quite unknown in the world until a few decades ago, the source being only suspected from the fact that chemical analyses showed small quantities of platinum in the basic igneous rock (dunite) which occurred in the Russian platinum placer fields. Later it was discovered that some lode ores contained platinum in amounts sufficient to be realized upon commercially. This was the case first, perhaps, with the Rambler copper mine, near the Encampment district, Wyoming, and later with the Boss mine, in Nevada. The Salt Chuck mine, in Alaska, was later found to carry commercial quantities of platinoids, especially palladium. But these had so meagre a production that they did not affect the platinum market, which continued to be supplied by placer mining, in which Colombia became prominent, following the reduction of output from Russia as one phase of the Bolshevist economic debâcle. Therefore the "something new out of Africa" in the shape of lode platinum promised to mean a veritable revolution.

The excitement and smoke have now begun to clear away, giving place to a lull after the storm; which is

disappointing, as always, to most of the speculators, although it does not affect the opinion of geologists and engineers. Many of the new companies have ceased operations, and the public deems that it has been unwarrantably disillusioned. Some of the stronger companies persist, and are showing earnings. They are attacking methodically the varied and new metallurgical problems, and are meeting with as much success as could have been predicted. The fact still remains that to this region the world will look for decades to come for an increasing portion of its platinum supply, which in time is likely to become the chief source. It is interesting to note that the market for palladium, one of the platinoid minerals which usually accompanies platinum in South Africa and elsewhere, is being actively developed: jewelers have begun to push it for jewelry in the same manner that platinum was successfully introduced for that use a few years ago. It is far less expensive than platinum, although more so than gold: so that it ought to find a market with jewelry buyers, whose chief demand, according to all the evidence, is that a thing should be expensive.

Sicily Turns to Electric Power for Economic Recovery

THAT THE MINING INDUSTRY in nearly all parts of the world is coming to a realization that it cannot prosper without adequate electrical power is exemplified by the recent decision of the Italians to completely electrify the Sicilian sulphur mines. Until about 1905, when America began working its sulphur deposits in Louisiana and Texas, Italy had a practical monopoly of the market for sulphur. Since that time the Italian production has steadily declined.

The sulphur mines affected cover nearly one-fifth of the area of Sicily, but have been handicapped by antiquated equipment. Though wage scales have always been low, the cost of production has been comparatively high.

Lately, electrification of the mines has been decided upon as a step in the direction of economical recovery. Electric power is to be supplied by a central plant at Catania and transmitted to all the sulphur-mining districts over a main power line operated at 40,000 volts, running between Catania, Caltanisetta, and Campo-Franco. A 10,000-volt line will be extended to the Caltanisetta-Sommatino district. Efforts are being made to complete all this work in less than three years. The cost of the new installation has been estimated by engineers at from 34,000,000 to 35,000,000 lire.

Dikes and Ores of the Mississippi Valley

AT THE MEETING last week of the Geological Society of America at Madison, announcement was made of the discovery of a dike of mica peridotite in eastern Tennessee north of Knoxville. This item, while seemingly of local interest only, is indeed significant as to the magmatic and metallogic history of a wide region. Occasional dikes of peridotite, frequently mica peridotite, are found in various localities in Kentucky, from the eastern to the western end. These dikes are especially notable in the fluorspar region, which passes over from western Kentucky to southern Illinois, and they also persist a little north, beyond the ore-magmatic region. They occur sparsely in southeastern Missouri, in a field of notable ore deposition—of lead, copper, nickel, cobalt, and barite. They occur in Arkansas, where there are metal deposits; and in Arkansas they carry diamonds. A dike has even been reported from eastern Kansas.

The petrographic similarity of these occasional dikes over this wide area testifies to the existence of a single magma underlying this province—a relatively quiet magma, since eruptions have been so few, and so gentle. Also, the coincidence of notable deposits of metallic and non-metallic ores and valuable minerals throughout this general broad area—deposits which in some instances have been acknowledged, practically without dissent, as connected genetically with the dikes—bespeaks a similar unity of origin for the ores of all these widespread mining districts, throughout an area the outer fringes of which might well include even the lead-zinc region at the junction of Iowa, Illinois, and Wisconsin, in which district no dikes have been discovered. Like the dikes of the Kentucky-Illinois field, the newly discovered Tennessee dike occurs in connection with pronounced faulting.

The date of all this scattered dike intrusion is not absolutely fixed, but the consensus of views of various geologists in different states would seem to place it around the close of the Cretaceous and beginning of the Tertiary, or at the time of the beginning of the great Rocky Mountain uplift, vulcanism, and ore injection. The faulting in the broad Mississippi region modifies the assumption of a quiet magma, in that it indicates great vertical differential adjustment of the flat-lying strata, which, although they run back in age to the Cambrian, have undergone no folding—only vertical movements, resulting in doming, in basining, and in differential faulting. Such crustal disturbances can hardly be due to any other cause than adjustments of the underlying magma—adjustments which may have been due to expansion resulting from an accumulated excess of volatile constituents, and subsequent shrinkage and depression due to their disengagement and escape. Most of the fault movements have long ago been adjusted, since the fault scarps have been subjugated by erosion. The violent earthquake which shook this region in 1812, however, which originated in and was confined in its intensity to this very region, testified that all unrest is even yet not at an end.

Prospecting in Panama

SYSTEMATIC PROSPECTING, involving the outlay of a large sum of money on the chance of developing, from old abandoned mines and from new prospects, important paying mines, is going on in the Republic of Panama, under a concession held by a British syndicate. Some 250 men are being employed, roads have been constructed, and several old mines are being reopened. This is the enterprise which caused such wild rumors in London a few months ago, that a new Rand had been discovered in Panama.

Central America has undoubted gold reserves—a

statement which applies to other Central American countries besides Panama. Considerable gold mining has been done, which came to a close at various stages. One of the drawbacks is the difficulty and cost of transportation, due to tropical rains and heavy vegetation, combined with lack of good roads and the cost of building and maintaining such roads. Another factor which has tended to hinder the operation of gold mine areas, but especially of tropical ones—is, the greater gold content of the ores, in most cases, near the surface.

Rock decomposition in the tropics is unusually active, and the result is that with the decay and removal of wall rocks, and the slower removal of the quartz ledges, the heavy gold becomes relatively concentrated in and near the outcrops, and is, moreover, freed from any original sulphide associate, such as pyrite, which may have accompanied it. It is, therefore, not only easy to mine but simple to recover by amalgamation. In depth the hard sulphide ores come in, lower grade, more difficult to break, and requiring cyanidation. This characteristic has led to the widespread rumor that the veins of Central America are "surface deposits." They are, on the contrary, veins of magmatic origin deposited from the same Tertiary vulcanism which has produced mineral deposits in the Cordilleran region of North and South America: they are especially associated with andesitic rocks. As to depth, they have the usual characteristics of these Tertiary veins, in that the primary oreshoots (once the primary ore is reached) may go hundreds of feet beneath the surface before the oreshoots show a tendency to shorten and the quantity of ore is diminished, which they are apt to do within at the most a thousand or more rarely 2,000 feet or more in depth. Mines of this type invariably require competent and scientifically directed management and a careful supervision of costs to insure an operating profit.

There is, then, an excellent chance of opening paying mines in this region and the developers who are operating so freely are doing a good work. Whether one, after having given the plan this benison, would respond to a request to put his own money into such a venture at this particular stage is quite another matter, the answer to which will depend on the size of the fund which the individual in question may have for speculation and also in large degree on what odds he requires and estimates he is getting.

The Forestry Problem

MINE TIMBERS and other uses consume annually a large supply of wood, and render the timber market and the location and situation of forests of special interest to mine operators. Some of the mines own their own forests and produce their own timbers and other lumber, where they are so located that it is cheaper to do this than to buy from the great sources of public supplies. Among the coal companies of the Eastern states this practice is widespread; and in a number of cases the companies not only cut their own wood supplies, but, impressed with the inadvisability of continued ravaging with no thought of replenishing, have taken to scientific commercial forestry, with selective cutting and even reforesting of areas denuded by fire, to avoid in the future importing so much timber from the South.

According to a recent bulletin published under the auspices of the Natural Resources Production Department of the United States Chamber of Commerce, during the past spring thirty-seven coal mining companies of Pennsylvania planted more than 1,565,000 trees on their property.

The whole forestry problem, as such, is of close interest to the miner and indeed to the whole public. The United States consumes annually over a third of all the wood used in the world, having a larger per-capita consumption than any other nation. In the present situation, this does not mean extravagance; it is only another phase of the great per-capita consumption of all materials in the United States, due to its unique industrial activity.

The past wastefulness and lack of proper regulation in the utilization of forests is being corrected: and in many uses cement, metals, and other substances are competing with or have replaced wood. The use of wood as fuel has been gradually partly replaced by coal and oil; nevertheless, it is somewhat surprising to learn that the use of wood as fuel still consumes the largest amount, being superior even to the consumption for lumber, which comes next; followed in the order of their importance by fencing, hewn ties, pulpwood, and finally mine timbers.

The most active lumber industry in the United States is now in the Northwest, particularly in Oregon, where the great size of the virgin timber, with the consequent large yield per acre and the cheapness of production, make it possible to ship it to the Eastern coast by way of the Panama Canal and dominate the soft-wood market, in competition with the sparse and more expensively logged residual soft-wood forests of New England and the Appalachians. Nevertheless, the hard-woods of the eastern and central states have their necessary diversified uses, and their special markets.

Forests can be destroyed by fire, flood, insects, or wind, whereas mineral deposits are indestructible; but mineral deposits cannot be restored, once utilized, whereas forest products can. Therefore industry demands and is constantly working toward a more efficient forest-using and growing—the protection from fires, the study and combating of insect enemies, the study of artificial aiding of forest growth, scientific and economically sound conservation, and, where need be, and most important, reforesting.

Around Ducktown, Tenn., where the forest and indeed all vegetation was destroyed by the sulphurous fumes from the smelters, the subsequent utilization of these fumes for the manufacture of sulphuric acid is permitting a slow reforestation, both natural and artificial, according to an editorial staff member of *Engineering and Mining Journal*, just returned from a Southern trip. But in the meantime the removal of vegetation exposed the humus of the soil to removal by rains, and subsequently active erosion formed gulleys and created a desert bad-land topography. In China, Asia Minor, and other countries where the timber and vegetation has been persistently closely cropped—by intensive wood gathering, by fire, or by too-close grazing—many formerly fertile areas have finally become almost barren wastes, or have, with the passing of time, been attacked by erosion and ruined.

Selective Flotation of Copper-Iron Ore at the Eustis Mine, in Quebec

Modern Methods of Concentration Responsible for Profitable Operation — Copper Mined Seventy-five Years Ago — Orebodies Are Lenses in Schist Containing Pyrite Impregnated with Chalcopyrite

By A. B. Parsons
Assistant Editor

UNTIL such time as the Horne Copper Corporation blows in its new copper smelter at Rouyn, the distinction of being the largest copper producer in the Province of Quebec will remain with the Eustis Mining Co. The Eustis mine, situated 12 miles south of Sherbrooke, has, in fact, been responsible for all of Quebec's modest production of copper in recent years.

Since adopting selective flotation at its concentrator in 1924, the company has been increasing production gradually until now the monthly output amounts to about 300,000 lb. of copper in a concentrate that assays 22 per cent; and, as a byproduct, 1,500 tons of pyritic concentrate averaging 50.3 per cent sulphur. An alkaline circuit is used for the copper recovery, the pulp subsequently being acidified to float the pyrite. Were it not for the excellent separation of the sulphides effected by flotation, it is doubtful if the property could be operated profitably at prevailing prices for copper and pyrite.

Concentrator at the Eustis mine

The fields in the foreground suggest the attractive setting of the property in Southern Quebec

History Repeats Itself

A thriving copper mining industry in the Eastern Province of Quebec was virtually destroyed by the collapse of the copper market at the close of the war—not in 1919, but in 1865. In July, 1864, copper reached a maximum of 59⅜c. per pound: within twelve months the price dropped to 29½c., and coincidently wiped out the profits of a score or more copper mines in the region around Sherbrooke. Since 1865, probably a hundred mining companies have dug away at several hundred copper deposits in Quebec, but without making real headway from the standpoint of profitable exploitation. Besides the Eustis, one other mine, the McDonald, operated by the Weedon Copper Co., produced on a sizeable scale during the period of high prices from 1915 to 1918, but it dropped out of the picture in 1919.

The Eustis mine, formerly and variously called the Lower Canada, Hartford, and Crown, has been operated continuously since 1879, and except for brief interruptions since its discovery in 1865. It was reputed in 1915 to have produced up to that time more than 1,000,000 tons of ore, and since then about 750,000 tons has been mined.

A brief history of the property appears in a report on the copper deposits of the province made for the Quebec Government in 1915. It seems that as early as 1869 a furnace was erected near the mine and 40 per cent regulus (matte) was made for shipment to Bergenport, N. J. Likewise a small sulphuric acid plant was built near St. Johns, but no market developed for the acid. Reduction works comprising about eighty "burners"—presumably roasters—and sixty furnaces were erected near the mine to treat the ore by "Henderson's wet process" in 1876. This yielded monthly 65 to 75 tons of precipitate assaying 75 per cent copper. The project was not a financial success, it is said.

Soon after 1880, a plant consisting of fifty roasting ovens and two blast furnaces was erected, but by 1885 the price of copper had declined from 19.12 to 10.83c. per pound; and this, in conjunction with trouble with "smoke farmers," apparently stopped production for a time, though operations did not cease entirely. In 1894 copper brought only 9.5c. per pound, and the Eustis mine reduced its staff by more than half! One hates to contemplate what would happen today if copper should decline to 9.5c.

In 1905 the first crushing and concentrating plant was built at the mine, with a capacity of twelve tons of feed per hour. A note to the effect that an "Elmore oil concentrator was installed" is interesting. A fire destroyed the concentrator, consisting of crushers, trommels, rolls, a Richards classifier, and eight Wilfley tables, in 1915. It was rebuilt immediately, the flow sheet apparently providing a duplication of the equipment just listed and in addition a Dorr thickener and some Callow flotation cells.

Selective Flotation Adopted in 1923

In 1919, following the World War, production was suspended; but during 1922 attention was directed to the development of a concentrating practice that would make operations profitable. Methods characterizing the old treatment had done little more than eliminate the gangue. The ore contains virtually no arsenic and the pyrite is highly desirable for making sulphuric acid. The problem, then, was to make a separation of the pyrite and chalcopyrite. Experimental work developed a flow sheet that was effective, and by October, 1923. alterations to the concentrator had been completed and production was resumed. Since then some improvements in the details of the treatment have been made, resulting in the present practice, which will be described after outlining briefly some features of the geology of the deposit and the method of mining.

Essentially, the orebodies are a series of lenticular masses arranged like the rungs of a ladder and inclosed in sericitic schists, described as being the metamorphic equivalents of quartz porphyry. The strike of the schists is northeast, whereas the dip to the southeast ranges from 25 to 70 deg. A report on "The Copper Deposits of the Eastern Townships of the Province of Quebec," by J. Austin Bancroft, declares that petrographic studies show plainly that the orebodies have been formed by processes of replacement. Especially the feldspar and quartz have been replaced by sulphides. Pyrite, sphalerite, galena, pyrrhotite, and chalcopyrite were developed in the order named. The first and last mentioned are predominant. A very little gold and silver are found.

Orebodies Replacements in Schists

Bancroft says regarding the genesis of the ore: "Apparently mineralization took place after or during the time when the rocks were being rendered schistose. The orebodies developed by replacement of the schists, through the action of solutions ascending at favorable points along zones where shearing processes had developed intense schistosity; the shearing was accompanied by a strong tendency to overthrusting, as is shown by the crumpling of the schists. Since the orebodies were formed they and the rocks that contain them have been subjected to pressure; that is shown by the local brecciation of the ore.

"Although the sulphides are most frequently associated with the schistose quartz porphyries, there are sufficient instances where they occur with the metamorphic equivalents of diabases, fine-grained diorites, etc., to show that the ore is not genetically confined to the porphyries. It seems possible that the brittle quartz porphyries developed more readily the degree and character of schistosity that would permit the passage of mineralizing solutions. The associations of these ore deposits suggest the conclusion reached by Dresser that the source of these sulphide ores seems to have been the schistose igneous rocks."

There appear to have been two stages of ore deposition: the first brought pyrite with little copper; the second was rich in copper. The later invasion progressed along zones of weakness in and near, and presumably created by, the first or pyritic penetration. For the most part the chalcopyritic ore agencies ascended within one of the pyritic lenses; but where the pyrite was particularly dense, the course was frequently diverted so as to penetrate the schist at the side of the pyrite, or, toward the edges of the lenses, to proceed along the same planes of schistosity.

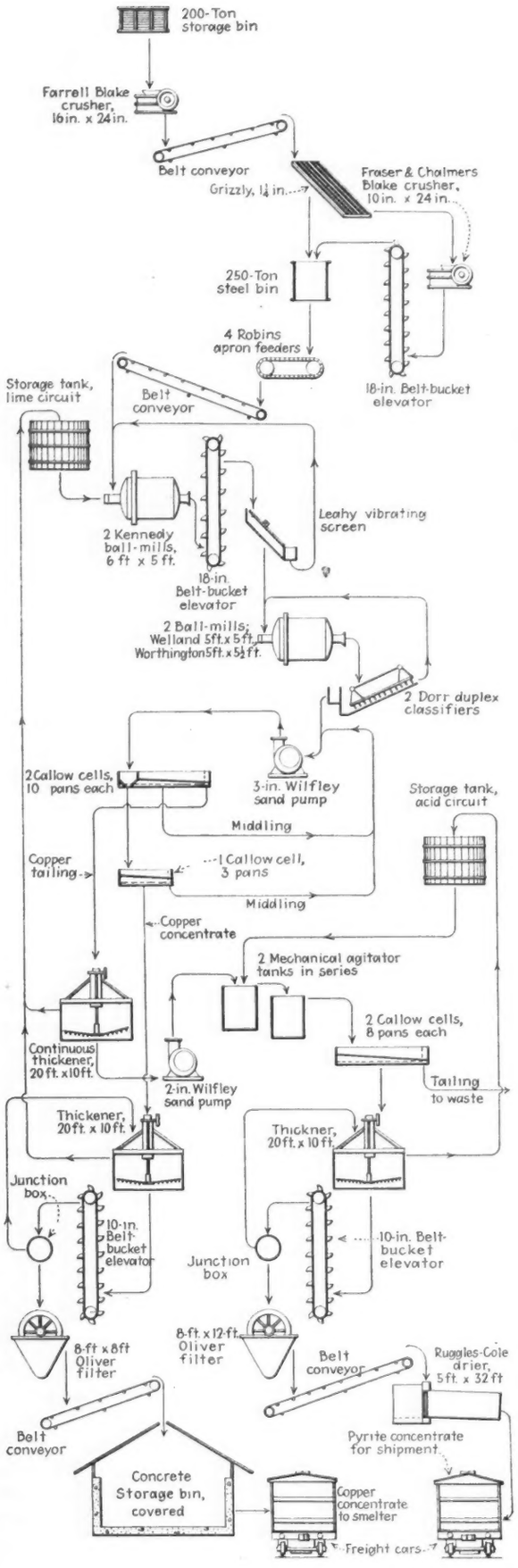
Apparently, at times, the pyritic injection met with such severe resistance in separating the foliations of the schist that it was forced to move transversely until a plane sufficiently weak to permit advance along it had been reached. This accounts for the *eschelon* or ladder-like arrangement of the deposits, which are at the same time continuous or connected. It also accounts for the tendency of the various lenses to converge at depth.

L. Chamberlin, surveyor; R. E. Hoppel, accountant; and D. J. Kennedy, mine captain, after the day's work

Quartz sericite, chlorite, dolomite, and ankerite are among the gangue minerals found in masses that appear to be solid sulphide ore. The ore contains streaks, bands, or masses of what is called "green rock" by the miners. It consists chiefly of grains of dolomite or ankerite with quartz, sericite, and crystals of rutile. This presumably has resulted from alteration of the schistose quartz porphyry by carbonate-carrying waters. The chalcopyrite usually is distributed through the pyrite and may appear as irregular streaks within the pyrite.

Individual lenses have averaged about 150 ft. in length along the strike and attain a thickness ranging up to 60 ft. The lowest lens now worked is about 400 ft. high. Walls are not sharply defined, the orebodies passing gradually into schist carrying diminishing quantities of sulphides.

The inclined shaft through which the mine is worked


200-Ton storage bin
Farrell Blake crusher, 16in. x 24in.
Belt conveyor
Grizzly, 1¼ in.
Fraser & Chalmers Blake crusher, 10in. x 24in.
250-Ton steel bin
4 Robins apron feeders
18-in. Belt-bucket elevator
Storage tank, lime circuit
Belt conveyor
2 Kennedy ball-mills, 6 ft x 5 ft.
Leahy vibrating screen
18-in. Belt-bucket elevator
2 Ball-mills; Welland 5ft.x 5ft., Worthington 5ft. x 5½ ft.
2 Dorr duplex classifiers
2 Callow cells, 10 pans each
3-in. Wilfley sand pump
Storage tank, acid circuit
Middling
Copper tailing
1 Callow cell, 3 pans
Middling
Copper concentrate
2 Mechanical agitator tanks in series
2 Callow cells, 8 pans each
Continuous thickener, 20 ft. x 10 ft.
2-in. Wilfley sand pump
Tailing to waste
Thickener, 20 ft. x 10 ft.
Thickner, 20 ft. x 10 ft.
Junction box
10-in. Belt-bucket elevator
Junction box
10-in. Belt-bucket elevator
8-ft x 8ft Oliver filter
8-ft. x 12-ft. Oliver filter
Belt conveyor
Ruggles-Coles drier, 5 ft. x 32 ft
Belt conveyor
Pyrite concentrate for shipment
Concrete Storage bin, covered
Copper concentrate to smelter
Freight cars

Flow sheet of the Eustis concentrator

slopes at an angle of about 35 deg. down to the 3,500 level (measured on the incline) and then flattens to 45 deg. for 200 ft., which brings it to the present bottom. An adit, 1,000 ft. long, intercepting the shaft 500 ft. below the surface, is now the main operating level. The 3,700-ft. depth is calculated from this intersection.

Until two years ago little timber had been put in the mine, but at that time parts of the shaft were timbered. Shrinkage stopes have recently been started, and this method of mining is to be used hereafter instead of the former practice of shooting the ore on to the sill and loading with hand shovels. When necessary a footwall "slice" will be taken, to be followed by one from the hanging wall. Not only are the two principal lenses on the lower levels producing, but in the upper workings portions of the orebodies left in the course of earlier operations are being mined.

D. J. Kennedy, the mine captain, gave me the following miscellaneous data regarding present operations: Canadian Ingersoll-Rand R 72 drills are used for development and Denver Rock Drill 773 stopers and "37" and "7" mounted drills are used for breaking ore, with Swedish hollow hexagonal steel. Ingersoll-Rand D.C.R. 23 "pluggers" also are employed. Ammonia powder is preferable because it is less likely to cause burning of the heavy sulphide ore and the liberation of sulphur dioxide in dangerous quantity. Gelatin is required in drifts, crosscuts, and raises, however. Wages on day's pay are $3.25 to $3.50; but development work is done on a "bonus" system, which nets the miner on an average $6 per foot for drifting and crosscutting (mucking included) and $3 per foot for raising. The ore is hoisted in skips to an underground pocket above the adit level, hauled to the mouth of the adit by electric locomotives, and lowered by means of a balanced surface tram in trains of three four-ton cars to the receiving bins at the mill.

Credit Due E. C. Wutke, Mill Superintendent

That there is nothing particularly unusual in the treatment in its broad aspects is indicated by the accompanying diagrammatic flow sheet. There are, however, sundry details that should be of interest to operators of flotation concentrators. For these data I am indebted to E. C. Wutke, the mill superintendent, who has, it seems to me, done remarkably well in getting results from a plant that, like most others that have been remodeled several times, is not as conveniently arranged nor as efficiently equipped as would be the case if a new one were to be built. For their liberal policy in allowing the details to be published I want to thank the Messrs. Eustis, of Boston, as well as John L. Baumann, resident manager at the property in Quebec.

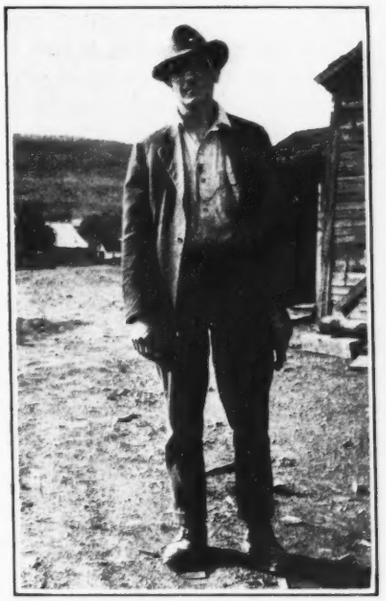
Most of the crushing equipment is an inheritance from former operations. The first Blake crusher reduces the ore to 4-in. size, the second to 1¼-in., thereby, in conjunction with the grizzly, giving a feed of 1¼-in. maximum to the primary ball mills. Beneath the flat-bottomed steel bin, 20 ft. in diameter by 20 ft. high, are four Robins apron feeders, each drawing from a chute in one of the quarter segments of the bottom of the bin. This arrangement makes it possible when necessary to withdraw nearly all of the contents without shoveling.

Hadfield chrome steel balls, 4-in. in diameter, and manganese steel lifters and grates, with ⅜-in. openings, are used in the Kennedy mills. Incidentally, it may be

remarked that on account of the preferential status of Great Britain, Hadfield balls have the advantage of paying only 10 per cent duty, against 25 per cent for similar material imported from the United States. The Kennedy mills are in closed circuit with a Leahy vibrating screen which has square openings measuring 0.027 in. In the Welland mill chilled steel liners are used, but in the Worthington manganese is preferred. Cast-steel balls, 2 in. in diameter, are the grinding media. The total consumption of balls for both primary and secondary grinding is 3.41 lb. per ton of ore milled. A typical screen analysis of the overflow of the classifiers, which becomes the flotation feed, is shown in Table I on this page.

The flotation cells are of the flat-bottom Callow type equipped with pans, 3 by 3 ft. in dimension. No. 4 interwoven cotton blankets made by the National Filter Cloth & Weaving Co. are used. The "iron" cells were provided with mohair blankets in an effort to overcome the rapid deterioration caused by the acid. They resisted the acid but became blinded so quickly as to give a net life no longer than the cotton. Accordingly the less expensive blankets are used, although their life is only about half as long as in the cells with alkaline solutions.

The pressure is maintained at between 2.5 and 3.5 lb. per square inch. As indicated on the flow sheet, the froth from only the first three pans in the copper roughers is sent to the cleaner, the remainder being returned to the circuit.



E. C. Wutke, mill superintendent, who is doing well with a rebuilt plant

Table I—Screen Analysis of Flotation Feed

Mesh	Per Cent
+ 60	1.0
+ 100 and — 60	4.0
+ 150 and — 100	11.0
+ 200 and — 150	19.0
— 200	65.0

No thickener is required between the classifiers and the rougher flotation cells. The high sulphide content of the ore makes the moisture lower than would appear from a casual inspection. Table II shows the dilution of pulps in various stages of the treatment.

Table II—Dilution of Pulps

Material	Parts of Water to 1 of Solid
Discharge primary mills	0.34
Discharge secondary mills	0.43
Feed "copper" cells	3.50
Feed "iron" cells	4.50

The matter of reagents is more interesting than any other phase of the operations. Table III shows the net consumption over a long period in the two circuits.

Table III—Consumption of Reagents

Material	Pounds Used per Ton Ore Milled
Copper Circuit	
Lime	11.5
T & T mixture	0.31
Pine oil	0.022
Iron Circuit	
Sulphuric acid, 66 deg. Bé.	20.0
Coal tar and creosote (50-50)	0.70
Potassium xanthate	0.18
Pine oil	0.015

Lime in slaked form is introduced by means of a screw feeder to the conveyor that carries the ore from the steel bin to the primary ball mills. The quantity is regulated by means of a dog and ratchet with an adjustment screw. Pine oil for the copper circuit is also fed to the primary ball mill, whereas the T & T mixture is introduced at the suction of the pump that elevates the feed to the rougher cells. Wheel and scraper reagent feeders of the usual type are used.

A material saving has been effected by heating the T & T mixture. The active reagent is thiocarbanilid, which is dissolved in orthotoluidine, usually in the ratio of 1 part of thio to 5 parts of ortho. The heating has made it possible in this particular plant to decrease the ratio to 1 to 3, thereby economizing largely on orthotoluidine without in any way impairing the efficiency of the concentration. To prevent the loss of heated mixture by evaporation, the small containing vat is covered with a cooled iron pan, on the bottom of which condensation of vapor takes place. The drops fall back into the vat.

After the removal of as much of the alkaline liquor as practicable in a continuous thickener, the copper flotation tailing is pumped to two 6x3-ft. tanks provided with mechanical agitators for acidification with sulphuric, 66 deg. Bé. At this point also the other reagents—xanthate, pine oil, coal tar, and cresote—are introduced and thoroughly stirred in.

The functions of the various reagents are well known. Lime "dampens" the flotative effect on the iron so that it is dropped with the gangue in the copper cells. The T & T is a collecting agent; the pine oil essentially a frother. After the copper has been removed the problem is one of simple flotation of pyrite from a gangue of siliceous and dolomitic material. The acid "revives" the pyrite and makes it amenable to floating. Pine oil again serves its usual purpose; coal tar and creosote probably function both as collecting and frothing agents; and xanthate serves as a collector. The success of the selective separation is indicated by the fact that the iron concentrate contains only 0.28 per cent of copper. The figures shown in Table IV give a summary of the results attained during the twelve-month period from June 1, 1925, to June 1, 1926.

Table IV—Concentrator Results June 1, 1925, to June 1, 1926

	Copper Flotation	Iron Flotation
Tons floated, dry	51,966.0	21,499.0
Head assay, copper, per cent	3.04	0.293
Head assay, iron, per cent	30.00	31.73
Concentrate assay, copper, per cent	22.10	0.28
Concentrate assay, iron, per cent	32.00	42.56
Tailing assay, copper, per cent	0.293	.....
Tailing assay, iron, per cent	.....	11.64
Recovery, per cent	91.57	87.15
Ratio of concentration	7.94-1	1.50-1

Obviously, the objects in view are essentially different in the two concentrations: high recovery is the first consideration in the copper work, with the grade secondary; on the contrary, grade is the primary object in the iron concentration with the recovery of lesser importance. Indeed, the market for the iron is not yet adequate to absorb the entire production.

A scheme to insure a thick feed to the filters is the introduction of "junction" boxes at the top of the elevators lifting the thickener underflows. If for any reason the pulp is thin, the gate in the junction box is adjusted so as to return it to the thickener instead of going to the filter. The filters receive pulp ranging from 50 to 70 per cent solids, the iron concentrate having the lower dilution, usually with at least 60 per cent solids.

Cake from the "iron" filter averages only 7 per cent moisture, to attain which it is necessary to replace the canvas cover about once a month. The moisture is further reduced to about 0.3 per cent by passing through the coal-fired Ruggles-Coles drier, putting the pyrite in condition for burning in the acid plant.

Former practice was to ship a mixed concentrate to a chemical plant at Capleton, about a mile from the mine. Here acid was made, after which the copper-bearing cinder was shipped to Norfolk, in Virginia, for smelting. The present procedure, of course, is to ship the copper concentrate to the smelter, and to market the high-grade pyrite for acid manufacture. One regular contract calls for 1,200 tons of pyrite per month, and other shipments have been made. However, a campaign to find wider markets is under way and is meeting with some success.

As has been remarked before, the enterprise is one that depends for its financial success entirely on the progress in the art of concentration as exemplified by selective flotation.

Why Machine-Made Bits Are Superior to Hand-Made Bits

Anyone familiar with rock drilling in mines and quarries will grant the claim that machine-made bits are superior to hand-made bits in drilling speed. Increased drilling speed is only one of several advantages that can be urged in behalf of machine-worked drill steels. The thing to be considered is over-all plant efficiency and economy. This according to a manufacturer.

There are several reasons why a machine-made bit will drill faster than a hand-made bit. The cutting edge of the machine-made bit is sharp and concentric. The material back of it is dense, having been compacted by hundreds of powerful hammer blows. The angle, of which the cutting edge is the apex, is correctly made so as to give the proper chipping blow. The clearance space between the wings of a machine-made bit are sufficiently wide to give ample room for rock cuttings to pass; and, at the same time, the wings are heavy enough to stand up under severe work. The wearing surfaces forged on the sides of the wings permit the drill to be used for a maximum time before losing its gage and having to be removed from the hole and resharpened. The sharpener-made bit is symmetrical. Because of this there is much less likelihood of holes "rifling." The machine-made bit will drill a smooth, round hole. This is not always true of hand-made bits. All the foregoing reasons are important, but the principal reason for the greater drilling speed of a machine-made bit is that it does not have to cut so much rock.

In practice, it is next to impossible to gage hand-made bits within a tolerance of $\frac{1}{8}$ in. Sharpener-made bits, on the other hand, can be gaged regularly to $\frac{1}{16}$ in. of the prescribed dimension; and, with few exceptions, a variation of $\frac{1}{16}$ in. in diameter in succeeding bits is quite satisfactory. Small as the difference seems between a variation of $\frac{1}{16}$ in. and $\frac{1}{8}$ in., still this difference in diameter, when drilling a 10-ft. hole, means that the succeeding bits of the larger diameter must cut through just so much more rock in effecting the desired penetration. A fair estimate would put the excess rock drilled at 50 per cent in the case of hand-made bits. Therefore, it is easy to understand why the machine-made bit will do its work faster and cost less in power consumption and in wear and tear on the drill, not to mention lightening the labor of the drill runner at the same time.

Another advantage of the machine-made bit is that it permits the drill operator to do productive work during a much longer part of a working shift. Because of the avoidance of "rifled" holes, and because of the ample passage for cuttings between the wings and the bit, the steel is not so likely to stick in the hole and to force the operator to lose valuable time in trying to loosen it. This is a common cause of lost time in flat-hole and down-hole work. When a steel is sharp, it cuts the rock; when a steel is dull, it strikes the rock an ineffectual blow. The energy of this ineffecutal blow, which is transmitted through the drill steel, sometimes breaks the steel or even the rock drill itself. This breakage, aside from the cost of the parts and the cost of making repairs, is expensive in that the miner may be idle and unproductive when his drill is out of commission. A reduction in the cost of repairs will be noticeable when sharpener-made bits instead of hand-made bits are generally used.

All these advantages will result in a much lower cost per foot of hole drilled. Again, a saving is effected because of the reduction in the number of drill steels needed to do a given amount of work. Inasmuch as a sharpener-made steel retains its cutting edge and gage much longer, it is possible to get nearly twice as much footage with such steel as is possible with a hand-made bit.

Emphasis should be placed always on seeing to it that the entire drill steel is in proper condition. That is to say, the shank is just as important as the bit, and this fact should never be lost sight of, no matter whether the steel is made up by hand or by machine. Shanks made on a sharpener are true in shape and in size. Therefore, they utilize the maximum power of the drill. Shanks made by hand may vary greatly in these particulars. If the shanks are even a little too long, the piston of the drill cannot travel its full length and, accordingly, cannot develop its full power before hitting the steel. On the other hand, if the shank is too short, much of the power of the piston's blow will be absorbed by the fronthead and the springs instead of being delivered to the drill steel.

In short, good drill steels, with properly made bits and shanks, will contribute much to better over-all plant operation. The drills will give maximum service; the holes will be drilled faster; and the blasting, mucking, hoisting, and other work will be carried out on schedule time while the efficiency of the entire plant will be increased proportionately.

Petroleum Found in Languedoc, Southern France

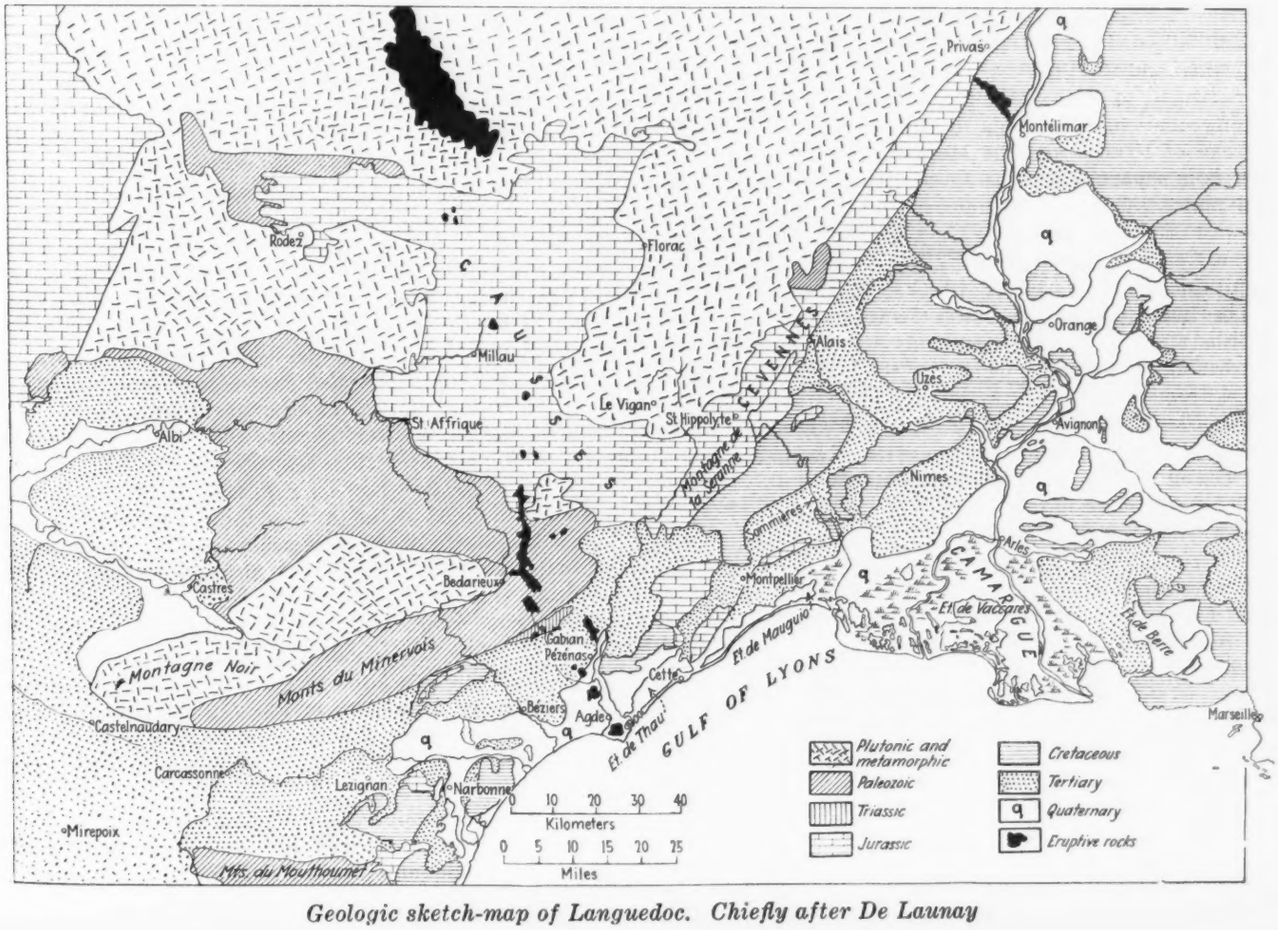
Government Drilling Brings in Three Producing Wells of 17,000 Barrels' Output to Date—Private Capital Now Interested—Structural Geology of the Region

By Arthur Huber Redfield
Washington, D. C.

THE FIVE DAYS from Sept. 6 to Sept. 10, 1914, will always be memorable in the history of France and of the world. Every French schoolboy will recognize them as the date of the first Battle of the Marne, in which Von Kluck's gray-green hosts were beaten back almost from the gates of Paris. In the courtyard of the Hôtel des Invalides the visitor to Paris may see one of the battered-looking taxicabs in which Gallieni's garrison troops rode out from Paris to the battle front to swell the ranks of Manoury's division at Meaux, the left jaw of the pincers with which Joffre gripped the rashly advancing German salient. Perhaps the dramatic incident of the taxicabs had its share in bringing to the attention of the French nation the vital importance of petroleum for national defense. Certainly the experiences of the World War changed France from a nation apparently indifferent to the source and control of its mineral oils to one of the most active in the endeavor to obtain control of petroleum supplies, crude and refined, both domestic and foreign.

Before the World War, from 1910 to 1913, the French consumption of mineral oils, as indicated by the net imports of petroleum products plus an insignificant domestic production of shale oil, averaged about 4,788,000 bbl. a year. In the first two years of the war the demand for mineral oils languished somewhat, but as the vital importance of petroleum for the conduct of the war became generally apparent, the French consumption of mineral oils rose from 4,302,058 bbl. in 1915 to 6,684,582 bbl. in 1918. With the return of peace the demand for petroleum products more than doubled the pre-war average. After the first two or three years of readjustment France consumed 10,121,332 bbl. in 1923, 12,711,335 bbl. in 1924, and about 15,750,000 bbl. in 1925, or an average of 9,876,579 bbl. for the first seven years since the Armistice.

Before the World War all mineral oils consumed in France were imported, except for 700,000 to 960,000 bbl. distilled from domestic oil shale. As one of the fruits of victory, France regained Alsace and with it the oil field of Pechelbronn, 25 miles north of Strasbourg, which produced 51,193 metric tons (357,184 bbl.) of crude oil in 1918. Under French management the mining of oil sands as well as ordinary drilling was extended, and the production increased to 70,693 tons (493,932 bbl.) in 1923, but decreased to 63,650 tons



Geologic sketch-map of Languedoc. Chiefly after De Launay

(444,723 bbl.) in 1925. But at no time has Alsace provided more than 4 or 5 per cent of France's requirements of mineral oils. For fully 95 per cent of its supply France depends on refined oils, imported chiefly from the United States (77 per cent of the total), Rumania (8.2 per cent), and Mexico (4.8 per cent).

Since the war French science and French commercial enterprise have joined forces to increase France's domestic supply of petroleum by the discovery of new pools. Prospecting and a little drilling have taken place in the Departments of Landes, Basses-Pyrenées, Pyrenées-Orientales, Aude, Hérault, Var, Rhône, Ain, Haute-Savoie, Puy-de-Dôme, Gironde, Charente-Inférieure, and Eure-et-Loire. The net results to date have been some encouraging shows of oil in Puy-de-Dôme, near Clermont-Ferrand, Pont-du-Château, and Riom; and a small production in Hérault at Gabian, in the section of France known since the Middle Ages as Languedoc. It will be the object of this paper, based on the published work of French geologists and engineers, to describe the latter occurrence.

Lower Languedoc Flat, Rolling Lowlands

Languedoc in the Middle Ages was a large and vaguely defined area west of the Rhone and south of the Loire in which the *langue d'oc*, a Romance tongue akin to Provençal and to Catalan, was spoken by the people and sung by the troubadours. In the eighteenth century, however, the Province of Languedoc consisted of Upper Languedoc, which comprised the Cévennes Mountains and the southern part of the central plateau, and Lower Languedoc, which comprised the Mediterranean lowlands west of the Rhone.

Lower Languedoc, in which petroleum has been sought and obtained, includes chiefly the departments of Gard, Hérault, and the northern and eastern parts of the Department of Aude. Geographically it consists of the rolling and flat lowlands lying between the central plateau of France and the Mediterranean Sea. On the east it is separated by the Rhone from the similar hills and plains of Lower Provence. On the west it opens by way of the Carcassonne Gateway, between the Montagne Noire and the Corbières, into the broad basin of Aquitaine.

The inner portion of Lower Languedoc is composed of hills and low limestone uplands known as *garrigues*, decreasing in height toward the sea. These are separated from the sea by low flat plains, marshy in places and bordered on the seaward side by a series of intercommunicating lagoons, such as the Étang de Thau, the Étang de Vic, and the Étang de Mauguio, held in by long, low sand bars.

Lower Languedoc is drained by a number of rivers which rise in the central plateau or in the Pyrenées, and flow directly or indirectly into the Mediterranean Sea. Chief of these are the Aude, which flows eastward past Carcassonne into the Mediterranean Sea north of Narbonne; the Orb, which flows southeastward past Béziers to the sea; the Hérault, which flows south-southeastward past Pézénas and Agde into the Mediterranean; the Vidourle, which flows past Sommières into the sea; the Gard, which flows east-southeastward past Anduze and Remoulins into the Rhone; and the Cèze, which flows east-southeastward from the Cévennes into the Rhone above Roquemaure.

The climate is warm, sunny, and somewhat dry, but subject to abrupt changes of weather, especially when the cold, violent northwest wind known as the *mistral* is blowing. The winters are mild; the summers generally hot and dry. The average temperature for January is about 6 deg. C. (42.8 deg. F.), and for July about 28 deg. C. (82.4 deg. F.). The rainfall ranges between 50 and 75 cm. (19.7 and 29.5 in.). Most of this falls in the winter; the summers are generally dry, with occasional violent storms.

In this warm, sunny, and generally mild climate grapes, olives, mulberries, and chestnuts flourish, especially on the hillsides. Indeed, Lower Languedoc supplies two-fifths of the wine produced in France. Grain-growing and stock-raising are relatively less important industries. Some coal and lignite, a little asphalt, iron, lead, zinc, and copper are mined, and salt is evaporated from the water of the coastal lagoons.

The cities reflect the resources of the region of which they are distributing centers. Carcassonne, famed for its well-preserved medieval walls and towers, is a clearing-house for grain, wine, fruit, textiles, leather, and cooperage. Narbonne, Béziers, Montpellier, and Nîmes, all dating from Roman times, are noted for their wine and brandy. At Alais silk, glass, and iron are manufactured. Cette is the chief wine port of the region.

Stratigraphy—Triassic the Oldest

Triassic—The oldest of the stratified rocks of which Lower Languedoc is built belong to the Triassic. This system, 8 to 80 meters (26 to 262 ft.) thick, rests directly and transgressively on the Pre-Cambrian schist and granite or on the upturned beds of the Carboniferous. It is composed of alternating beds of conglomerate, puddingstone, compact limestone which is locally magnesian, sandstone, sand, and clayey marl. The Triassic of Languedoc, like that of Germany, may be divided into three series: the Bunter, the Muschelkalk, and the Keuper. The lower sandy stage of the Triassic of Languedoc corresponds to the German Bunter, the middle limestone stage represents the Muschelkalk, and the upper marl and gypsum stage the Keuper.

In Hérault the Triassic crops out only along the border of the central plateau. It comprises for the most part only the lower and upper series of the system, the middle being thin and in places apparently lacking or not yet distinguished from the upper series.

The Bunter sandstone (*les grès bigarrés*) of Hérault is represented by only 10 to 30 meters (33 to 98 ft.) of coarse sandstone or conglomerate composed of siliceous grains and pebbles. It is exposed in the valleys of Lamalou and Lodève and on a great number of points on the south slope of the Avant-Monts. The basal conglomerate, formed of granitic débris, attains a thickness of 8 meters (26 ft.). It may be observed at St.-Bonnet and St.-Croix-de-Cadorle, near Lasalle. The overlying puddingstone, 3 or 4 meters (10 to 13 ft.) thick, is formed of pebbles of white quartz, many of which are quite large, joined by a red or brown clayey cement. At Caronules, near Alais, and on the Col du Mas de l'Air this puddingstone contains argentiferous galena. The upper beds of the series, which are fine-grained and siliceous, are quarried for building stone at Lamalou and Formis, near Lodève. Fossils are rare in the Lower Triassic of Hérault. Near Lodève the Bunter sandstone contains footprints of a *Cheirotherium* or of a labyrinthodont.

In Hérault the Muschelkalk is represented by a few

limestone beds which outcrop principally in the vicinity of Olmet, near Lodève. In Gard the grayish or yellowish limestone which is considered to represent the Muschelkalk is 20 to 30 meters (66 to 98 ft.) thick. It is compact, hard, and locally magnesian. At certain places the rock is honeycombed with small cavities, either geodic or filled with calc spar. In some places it contains grains of quartz. This limestone is especially well developed at St.-Bonnet and at St.-Jean-du-Gard. At Boissezan occurs black marble with white spots of anhydrite. The Muschelkalk contains limonite which is mined at Le Travers (Bessèges) and both limonite and hematite which are worked at Coste-de-Long (Bordezac). This series includes thick deposits of grayish and clayey gypsum, and veins of white fibrous or pink saccharoid gypsum. This is worked at Arrigas, Monoblet, St.-Bonnet, Ste.-Croix, St.-Jean-du-Gard, Lasalle, and St.-Ambroix. No fossils occur in the Muschelkalk of Gard, but it is correlated by its stratigraphic position.

The Keuper or *"marnes irisées"* formed by alternating beds of clay, marl, and sandstone, of bright and striking colors, occurs in Hérault in the valley of Lamalou, in the upper valley of the Orb, around the basin of Lodève, and near Roujan and Clermont-l'Hérault. In many places beds of gypsum are intercalated in the marl.

The Keuper of Gard consists of 30 to 50 meters (98 to 164 ft.) of sandstone, sand, and foliated marl. The fine-grained sandstone of the Upper Triassic is quartzose and feldspathic; the cement which binds the grains is limy or clayey. The sandstone is white, yellowish, or reddish, varying locally in appearance. The sand which overlies this sandstone is fine-grained, quartzose, yellowish, a little clayey, and locally micaceous. The marl which constitutes the upper part of the series is clayey, not very shaly, and easy to break. It presents shades of yellow, violet, green, and wine-red. Some beds are used for clay. The Keuper is exposed at St.-Jean-du-Gard, at Le Vigan, and at Alzon. Pyrolusite occurs in the fissures of the sandstone at Camprieu. A dull-black lignite occurs in the sandstone near Pont-de-Salindres (Thoiras) and traces of lignite at St.-Jean-du-Pin. Chalky barytine occurs at Laval. In the Triassic marl near Alzon are geodes lined with crystals of hyaline quartz or of calcite. Fuller's earth occurs in this vicinity at Cailaret. The Upper Triassic sandstone furnishes good building stone, and is quarried at Camprieu, Soredourgues, Marcassargues (St.-Jean-du-Gard), Vabres, Aujoc, and at Randavel (Trèves).

No organic remains, except some plant imprints, have yet been found in the Upper Triassic sandstone.

Marine Deposits Mark Jurassic

Jurassic—The Lower Liassic is absent from Languedoc. Beginning with the Middle and Upper Lias, the Jurassic system of Lower Languedoc is marked by the continuity of its marine deposits. The succession of these beds occurs without interruption up to and into the Lower Cretaceous. Marl and marly limestone, ordinarily dark colored, dominate at the base of the system; but higher in the stratigraphic scale the beds become progressively more calcareous, and the upper strata consist generally of pure limestone. The Jurassic limestone is largely dolomitized from the Bajocian and the Bathonian or even in some places from the Lias upward. Not only single formations but even whole stages of the Jurassic are thus altered. The oölitic facies of the Jurassic is rare in Lower Languedoc.

The Jurassic varies in thickness, diminishing to the south. It measures 400 to 500 meters (1,312 to 1,640 ft.) in the north of the Department of Hérault, whereas in the Montagne de la Gardiole, near the coast, 150 meters represents the entire Middle and Upper Jurassic.

Limes and Marls in Cretaceous

Cretaceous — Above the Jurassic, the Neocomian group of the Lower Cretaceous is represented in Hérault by soft whitish or grayish limestone, easily cracked by frost. It occurs only in the eastern part of the Arrondissement of Montpellier, where it advances into the Jurassic formations, as in the depression of La Cadière, between Ganges and St.-Hippolyte, in the Canton of Claret, and in parts of the Cantons of Motelles, St.-Martin-de-Londres, and Castries.

At the base of the Neocomian the Berriasian consists of limestone which becomes marly in its upper beds. The Berriasian is well developed in the south of Gard (St.-Hippolyte region), and less fossiliferous near Montpellier, where it occupies broad areas (Prade region).

In Gard the succession begins with the Valanginian, a marly formation containing pyritous fossils. This group is not met in this form in the south of the Department of Hérault or even in the St.-Loup region, where the Valanginian is represented by marl which is almost without fossils. The upper part of the Valanginian becomes calcareous in the St.-Hippolyte region, and in that of the Bois-de-Carnas and of Gailhan. In the Montpellier region the Upper Valanginian is represented by alternating blue and yellow glistening limestone. This facies terminates the Lower Cretaceous system in the immediate vicinity of Montpellier.

The upper part of the Valanginian is hard to separate from the base of the Hauterivian, which is more calcareous. The Upper Hauterivian is lacking in the south of the Department of Hérault except at Pic-St.-Loup, where a formation of saccharoid limestone, containing corals, occurs.

The Berremian is the highest stage of the Cretaceous occurring in Gard. Neither the Berremian nor the Urgonian appears to occur in the area between Hérault and Vidourle rivers. The Middle and Upper Cretaceous are generally absent from Lower Languedoc.

Sandstones and Conglomerates More Common in Tertiary

Tertiary—At the base of the Eocene, sandy and clayey beds, chiefly of a reddish color, predominate, intermingled locally with coarse conglomerate and pebbles. The Lower Eocene is overlain by thin grayish porous limestone (Lutetian) 2 to 4 meters (6.6 to 13.2 ft.) thick. The limestone is succeeded by Bartonian yellow clay and yellow marl, sandstone, and coarse conglomerate. The Ludian is composed of thin-plated limestone.

In the Lower Oligocene, the Lattorfian or Infra-Tongrian consists of 200 meters (656 ft.) of alternating sandstone, limestone, and marl, deposited in slightly brackish lagoons. Its lowest member consists of platy limestone and foliated shale overlain by compact limestone or yellow marl. The middle member consists of pyritic sand and clay, with lenses of plant-bearing sandstone. It is thick in the south, but thins out to the north and disappears near Barjac. The upper member begins with limestone, followed by lignite measures and by marl and limestone laid down in almost fresh water.

In the Middle Oligocene the Rupelian or Tongrian is composed of 300 to 400 meters (984 to 1,320 ft.) of a basal pottery clay, followed by sandstone alternating with porous limestone and variegated marl, and these in turn by puddingstone, conglomerate, and limonite. The whole stage represents detritus and torrential deposits laid down in shallow but slowly subsiding lakes.

The upper beds of the Tongrian merge imperceptibly into the basal beds of the Aquitanian (Upper Oligocene). This consists of 200 meters (656 ft.) of conglomerate and puddingstone, which represent the ancient alluvial fans formed by the torrential streams which discharged into the Tertiary lakes. The Aquitanian is represented at Brujas, Bessas, and St.-Sauveur by marl and limestone with thin seams of lignite. The base of the Aquitanian in the Montonlieu basin is formed by lignite, overlain by yellowish marl, and this in turn by fine-grained yellow sandstone and by coarse conglomerate composed of pebbles of Mesozoic rocks. In the Sommières basin this stage is represented by conglomerate and fresh-water limestone. In the Montpellier region the Aquitanian stage consists of marine beds, chiefly blue marl with intercalated sandy beds.

"Calcaire Moellon" for Building

The Burdigalian (Lower Miocene) is essentially composed of white limestone of littoral aspect, known by the name of *calcaire moellon.* It has been extensively used as a building stone in the construction of Montpellier. The base of the stage consists of sandy marl alternating with shell beds. In the Sommières basin the floor of the *calcaire moellon* consists of conglomerate of green pebbles, and the roof bed of marly limestone. The Helvetian (Middle Miocene) consists generally of blue marl, locally sandy, of littoral origin. In the Tortonian the blue marl gives way to limestone. The Sarmatian is entirely lacking between Hérault and Vidourle rivers.

In the west of the Department of Hérault Pontian beds of continental origin overlie unconformably the marine Tortonian.

The Lower Pliocene does not occur in the area between Hérault and Vidourle rivers. Near Montpellier the base of the Pliocene is formed by yellow or whitish micaceous sand, fine-grained, cross-bedded, and apparently of Plaisancian age. Near Generac the base of the formation is constituted by whitish or yellowish marl, containing no fossils. In the vicinity of Nîmes the Plaisancian is lacking. It is well exposed in the triangle included between Comps, Remoulins, and Aramon, where blue marl of sub-Apennine facies covers a wide area. Near Théziers the Plaisancian begins with grayish *Congeria* marl, overlain by blue marine clay.

Upon the blue marl of the Plaisancian lies a thick series of yellowish-white marine sand, of Astian (Middle Pliocene) age, whose outcrops extend from Nîmes to Montpellier. Near Théziers the Astian is represented by bluish gypsiferous marl containing a brackish-water fauna. These are overlain by sand containing *Balani* and *Ostreae,* and that in turn by a second marl of brackish-water origin. This last formation is represented near St.-Genies and St.-Laurent-des-Arbres by gray brackish-water marl containing lignite. The upper member of the Plaisancian consists of cross-bedded yellowish soft sandstone.

The Sicilian (Upper Pliocene) consists of thick deposits of pebbles of Alpine origin, chiefly composed of white quartzite with a characteristic ferruginous patina. These Alpine pebbles may be traced from Roquemaure beyond Montpellier. The zone is 12 km. broad near Nîmes.

Quaternary—The Quaternary deposits consist chiefly of coastal sand and swamp loam and of alluvial terraces in the valley of the Rhone and its tributaries.

Geologic History of Southern Languedoc

During the greater part of the Paleozoic era southern Languedoc remained submerged beneath the waters of broad marine gulfs open to the south and east. The so-called Caledonian mountain-building took place near the end of the Silurian, as is evidenced by the wide transgression of the Devonian and by an angular unconformity.

At the end of the Devonian the introduction of corals near the top of the system gives evidence of shallowing waters which marked the beginning of the Hercynian folding, which reached its climax in the Lower Carboniferous. The Central Massive was folded into chains of mountains which were peneplaned by the beginning of the Upper Carboniferous into a low continental surface (as is evidenced by land plants at the top of the Culm), dotted with lakes and lagoons in which the Coal Measures were laid down. This was succeeded by a shallow sea in which corals abounded.

With the upper Coal Measures the sea had completely receded from the Montagne Noire, which was then connected with the Central Massive. During the Permian the marine deposits completely disappeared and were replaced by terrestrial deposits in which conifers predominated. This indicates the extension of the continent which occupies the site of the Central Plateau of France.

The Triassic witnessed a progressive return of the sea, which was shallow, as attested by the sandy strata of littoral facies which surround the Montagne Noire and the foot of the Cevennes, and rest with complete unconformity on the Upper Permian. The sea became deeper for a brief while in the Middle Triassic, but gave way in the Upper Triassic to shallow water and coastal lagoons.

From this point the geologic history of Languedoc may be followed step by step, as the entire Jurassic system and a part at least of the Cretaceous are well represented in the region. The sea, shallow during the Lias, washed the foot of the Central Plateau and of the Montagne Noire, which were separated by a great depression in which thick limestone beds were laid down. Marine conditions prevailed throughout the Jurassic. A deep sea separated Languedoc from Provence, where coral reefs similar to those of Languedoc occur.

The beginning of the Cretaceous (Valanginian) was a period of marine invasion; but in the middle of the Hauterivian the marine strata gave way in western Hérault to continental deposits. Marine conditions persisted between Hérault and Vidourle rivers during all the Lower Cretaceous, with a tendency, however, to uplift toward the west. In northern Gard, marine conditions continued during the entire Hauterivian and the Lower Barremian, followed by emergence in the Upper Barremian. The area between Hérault and Vidourle rivers remained above sea level from the Barremian continuously through the Middle and most of the Upper Cretaceous. Accordingly marine deposits from the Barremian through the Senonian are lacking. This emergence was part of a general shallowing of the Upper Cretaceous seas of southern France.

During all this long period the eastern part of southern France remained above water; and it is probable that a part at least of Gard was emergent during the first part of the Upper Cretaceous. To the north, however, near Uzès, marine sedimentation was resumed with the Aptian and continued during the Cenomanian, the Turonian, and the Senonian, but with littoral characters, as is shown by the abundance of sandy beds and the intercalation toward the top of the beds of *Rudistes*.

On the continental surface which existed during the Middle Cretaceous deposits of ironstone were laid down in the hollows of the underlying beds, and locally in the Basin of Villeveyrac bauxite deposits. The bauxite is overlain by the lowest beds of the Villeveyrac basin, and is therefore older than the Begudian (Upper Montanan) of Provence. On the other hand, it has been shown that they are younger than the Urgonian.

The chief emergence of Lower Languedoc occurred at the end of the Cretaceous. This was the end of a period of wrinkling of the earth's crust which ended before the Danian. At the close of the Cretaceous, great lakes, not very high above sea level, were established all over Languedoc and a part of Provence, as is shown near Barron by the deposits of sandstone followed by limestone containing lacustrine fossils.

The movement of emergence which had begun at the end of the Cretaceous continued during the Eocene, which in the south of France is hard to delimit from the Cretaceous, giving rise to more or less littoral deposits and later to lacustrine deposits. The Tertiary in Languedoc was characterized by alternating emergence and submergence.

Continental conditions prevailing in the Lower Eocene are attested by the sandy, clayey, and locally coarse texture of the sediment laid down by swift streams. In the Middle Eocene continuous beds of limestone were deposited from Lower Provence to Hérault and even into Aude, in the quiet waters of a lagoon which bordered the Lutetian (Lower Eocene) continent. Some indications of more rapid sedimentation are given in the sandstone and conglomerate beds of the Bartonian (Middle Eocene).

The lagoons of the Upper Eocene were manifestly as extensive as those of the Lower Eocene; but the beds laid down in them have undergone a severer denudation. Several remnants which have successfully resisted erosion give evidence that they originally extended in the Department of Hérault even beyond Montpellier. As early as the beginning of the Oligocene the lagoons were in communication with the sea; the waters became brackish and permitted the development of *Potamides*. The waters could not, however, have been very salty, since the genera *Limnaea* and *Planorbis* continued to flourish in them.

A New Period of Folding

Between the Eocene and Oligocene epochs Lower Languedoc underwent a series of orogenic movements, a reflection of the Pyrenean mountain-folding which modified the relief of the region. The relief of Lower Languedoc had already been sketched at the end of the Cretaceous; it remained for Pre-Oligocene movements to give it its definite aspect. This new period of folding seems to have been more intense than the preceding. Upon the upturned beds of the Middle Eocene the basal beds of the Lower Oligocene rest transgressively.

During the Sannoisian (Lower Oligocene) a progressive marine invasion of the lagoons, from south to north, took place. In the Stampian (Middle Oligocene) the brackish lagoons disappeared completely. Irregular torrential streams rapidly filled the lake of Alais. The accumulation of thick beds of coarse conglomerate is explained by the progressive deepening of the lake.

The Aquitanian (Upper Oligocene) was also a continental stage for most of Languedoc, but as erosion has removed most of the deposits of this age, nothing definite can be affirmed on this subject. The shore line appears to have passed through Carry, Montpellier, and Nîmes.

Miocene Beds Scarcely Disturbed

The first marine invasion during the Middle Tertiary began with the Upper Aquitanian. It did not extend more than a few kilometers beyond Montpellier. Marine conditions continued in the Montpellier region until near the end of the Tortonian (Middle Miocene). During the Miocene the sea advanced farther and reached its greatest extent near the end of the Helvetian. The basin of Hérault River as far as the peak of St.-Guilhem-le-Desert was submerged; on the east the sea covered all the region of Montpellier, of Castries, and of Sommières. The Helvetian sea extended up the Rhone as far as Lyon. The Pontian (Upper Miocene) is not represented in the region between Hérault and Vidourle rivers, which was probably at that time a continental area. Near the end of the Miocene the marine deposits began to alternate with limestone and marl containing fresh-water fauna, thus demonstrating the progressive emergence of the region. This was the result of a new phase of folding and faulting, contemporaneous with that which formed the Alpine ranges. The Miocene was not marked in Languedoc, however, by the intense organic movements characteristic of the Alpine region. The Miocene beds of Languedoc have scarcely been disturbed from their original horizontal position.

At the beginning of the Pliocene, the Plaisancian sea invaded the Rhone valley, forming a long fiord which extended to the Loire River near Givors. The sea in Gard, however, washed the low hills which dominate the Plain of Nîmes from Lunel to Nemoulins, forming a small gulf near Théziers, and extending to Avignon. A few islands of Neocomian strata probably existed.

In Hérault, the Pliocene epoch modified but little the relief which had been definitely outlined as early as the Pontian. The sea which laid down the Plaisancian (Lower Pliocene) sand of Montpellier did not pass this city, but soon withdrew, giving place to brackish-water lagoons which became progressively less saline, so that at the end of the Middle Pliocene there existed only fresh-water lakes of limited extent. Similarly the fiord which occupied the basin of the Rhone lost some of its salinity and became a sort of brackish lagoon in which a number of *Potamides* developed at the end of the Astian. Many continental deposits were laid down.

Conditions Like Those of Today in Upper Pliocene

In the Upper Pliocene conditions resembled those of the present. The Rhone valley, now entirely continental, was traversed by a swift river which poured a great quantity of Alpine pebbles over a broad area extending from the Alps to the sea. In Hérault alluvium and débris from the Montagne Noire were laid down in places.

During the Pliocene volcanic activity was renewed. Numerous flows of basalt occurred in the lower valley of Hérault River near Agde, and in the immediate vicinity of Montpellier (Montferrier, Grabels, Maguelonne).

In the Pleistocene glacial period, the torrents resulting from the melting ice and snow rushed down the Rhone valley and partly removed the Pliocene alluvial deposits. The Rhone cut a new course at a lower level than the course occupied during the Pliocene and deposited new alluvial terraces, extensive in the Rhone valley, but scarcely noticeable as far west as Nîmes.

The valleys formed during the Pliocene were but little modified during the Quaternary. Only a few caves in the Mesozoic limestone were filled during that period.

Two Natural Regions in Lower Languedoc

Lower Languedoc includes two natural regions: (1) An inner zone of low hills composed of folded Mesozoic strata, and (2) a broad, low coastal zone of Tertiary and Quaternary beds.

West of Narbonne and south of Orbieu River the Mesozoic beds of the inner, hilly zone are folded into a jumble of sharp, faulted, and overturned anticlines, trending variously north-south, northeast-southwest, or northwest-southeast, and exposing on their crests the Upper-Triassic marl, Jurassic limestone or Cretaceous sandstone, marl, and limestone. Several of these anticlines are overthrust to the west.

Between Orbieu and Aude rivers the Upper Cretaceous and Eocene beds are bent into more moderately folded anticlines trending northeast-southwest or east-west. Chief of these are the Lagrasse anticline, formed of Upper Cretaceous limestone and marl and Eocene sandstone, limestone, and marl, and the Mont Alaric anticline, which brings to the surface south of Capendu the Upper Devonian and Lower Carboniferous beds from beneath the Upper Cretaceous and Eocene beds of which the anticline is chiefly composed. These folds are continued in the domes of the Serre d'Oupia and of Ste.-Vallière, formed of Eocene lacustrine limestone, and in the folds of the low St.-Chinian range.

North of Aude River lies a broad syncline filled with Eocene limestone, which is apparently little disturbed; and north of this syncline the northwesterly boundary of Lower Languedoc is constituted by the front of the Central Plateau of France. In the south of the Department of Hérault this is represented by the Montagne Noire, a mass of metamorphosed Paleozoic crystalline rocks and gneiss; in northern Hérault and southern Gard it consists of the Limestone Cévennes or *Causses*, a dissected plateau of almost horizontal but much faulted Jurassic limestone; and in western Gard it consists of the crystalline Cévennes, composed of granite and Pre-Cambrian schist.

The Cevennes Fault

Both the Jurassic limestone plateau and the Paleozoic and older rocks of the Cévennes are cut off on the southeast by a great longitudinal fault (Cévennes fault), or rather by a zone of fractures relayed over a considerable distance, which separates the Central Plateau from the moderately folded zone to the south and east. The Cévennes fault zone, 1 to 2 kilometers ($\frac{5}{8}$ to $1\frac{1}{4}$ miles) wide, is outlined by a rectilinear chain of low mountains, which extend in a general direction of N. 34 deg. E. North of Alais it is a faulted zone; south of Alais it merges into a sharp fold in which the Lower Liassic beds are tilted to the vertical and even overthrust somewhat to the southeast.

In the interior or hilly zone of Hérault may be distinguished two groups of folds, separated by a structural depression which corresponds to the lower courses of the Orb and Hérault rivers. The western group includes the folds of the Montagne de la Clape, south of Narbonne, and those of St.-Chinian. The former folds bring to the surface the Cretaceous beds along the coast; the latter are overturned to the north against the buttress of the Montagne Noire and expose not only the Upper Cretaceous (Danian) but also the Jurassic and even the Triassic. Three folds may be distinguished in the St.-Chinian group, those of Pierrerue, Cazedarnes, and Cazouls. They form an integral part of the low Montagnes du Minervois and serve as an intermediary between the Paleozoic of those mountains and the plain.

Between the western and eastern groups of folds the pebbly basins of the Biterre and the Agde regions have been affected by only insignificant movements of the earth's crust. As evidence of these may be observed small volcanic cones, such as the Montagne d'Agde, which suggest that deep-seated dislocations may be hidden by the mantle of younger formations.

However, between the eastern and western groups of folds, detailed geologic study of the Gabian area by Barrabé revealed the presence of distinct folds trending generally east-northeast-west-southwest. The best defined of these is an anticline exposed in the valley of Tongue River about 2 kilometers ($1\frac{1}{4}$ miles) south-southwest of Gabian.

The Eastern Folds

The eastern group of folds may be subdivided into three anticlines separated by synclinal depressions. There are the folds of St.-Loup, of Montpellier, and of Gardiole. To the north of St.-Loup plateaus of tabular structure mark the end of the folded zone. The succession of outcrops shows that the intensity of folding decreases progressively as one approaches the sea. The St.-Loup fold exposes in certain places the lower beds of the Lias; in the Montpellier fold nothing lower than the Middle Lias is exposed; and in the Gardiole fold the oldest series exposed is the Middle Jurassic. The same may be observed of the intervening depressions which have filled respectively with the Eocene, Miocene, and Pliocene beds.

The St.-Loup anticline extends from a little west of St.-Methieu in an east-northeast-west-southwest direction through Cazevieille and Viols-le-Fort, and ends a little north of Puechabon. It brings up the Sinemurian (Lower Liassic) dark-gray limestone on a small dome east of Cazevieille, and the Bathonian on an elongated dome extending east and west of Viols-le-Fort.

East of Pic-St.-Loup the fold seems to plunge beneath the Cretaceous and Tertiary of the plain which extends eastward to Vidourle River. Transverse faults interrupt the fold throughout this region. It may be resumed in the anticline north of Nîmes.

In the Montpellier area the St.-Loup anticline is more or less symmetric. Its southern limb, however, is a little broader than its northern limb. Along its southern border the beds are cut by a series of faults extending north and south.

The synclinal depression between the St.-Loup anticline and the succeeding Montpellier anticline has under-

gone a series of flexures at right angles to the direction of the main axes of folding. These flexures are accompanied by north-and-south faults. This syncline extends from the valley of Hérault River eastward almost to Vidourle River.

Jurassic Beds Exposed in Montpellier Anticline

The Montpellier anticline extends from Hérault River almost to Vidourle River. It is asymmetric in form; its southern limb is broad and regular and forms a sort of plateau of Jurassic beds dipping gently southward. A few minor folds parallel to the main axis of folding occur. The northern limb, on the contrary, is very narrow and much disturbed. It consists of a narrow band of Jurassic strata outcropping between Aumélas and the road from Montpellier to Grabels. The entire series is exposed, however. East of the Montpellier-Grabels road the anticline has been drawn out, which has caused the folding under of a part of the beds which should normally outcrop in turn from south to north.

The axis of this anticline may be distinguished very definitely between Murviel and St.-Georges-d'Orques, where the upper Liassic is exposed. It extends westward toward the Chateau d'Aumélas; and eastward it may be followed by the limestone mass of the Chateau d'O and of the Bois des Seigneurs. Beyond this point the southern limb disappears completely beneath the Tertiary. The northern limb continues to exist, but shows the results of the drawing-out process which has been determined in its eastern half. Near Castelnau the Berriasian and Valanginian beds have been folded under, while the Hauterivian limestone is brought into an immediate contact with the Upper Jurassic, which has been overthrust pronouncedly to the north. Northward may be seen the various Hauterivian beds upturned and passing in normal fashion under the Lower Eocene.

Between the Montpellier fold and the Gardiole fold on the one hand and between Montpellier and the Étang de Thau on the other extends a broad synclinal depression filled with Miocene strata. This depression appears to extend beyond Montpellier in the Plain of Mauguio, where it disappears completely. Farther to the south a last series of folds constitutes the small massif of La Gardiole, which extends along the Mediterranean shore between Cette and Montpellier. Here an anticline, with Bathonian siliceous limestone, Callovian marl, and Oxfordian marl exposed along its crest, occurs on the west slope of the Montagne de la Gardiole.

Between the folded zone of Hérault and a similar folded zone of Gard to the northeast lies the Tertiary basin of Sommières. This basin is filled with Stampian marl and gravel and upper Eocene limestone. It has a geologic constitution similar to that of the Tertiary basin of Alais, with some difference of details.

Northwest of Nîmes is an anticline broken in many places by faults trending northeast-southwest and bending slightly to the south. The axis of the anticline begins in the area between St.-Gervasy and Courbessac, trends toward the depression of La Vaunage, passes north of Nîmes, and after turning slightly to the south dies out beneath the Miocene hills of Aubais and of Mus. On the crest of the anticline the Valanginian is exposed, flanked on both sides by the Hauterivian and the Barremian.

The Nîmes anticline seems to be a prolongation of the St.-Loup anticline of Hérault. It is united beyond the valley of the Gardon with the Plateau or *Causse* of Uzès, which has the same structure and the same geologic composition; it is a low plateau not exceeding 180 meters (591 ft.) in average altitude. The *Causse* of Uzès is broken by deep and tortuous faults, at the bottom of which the Gardon and the Cèze flow about 150 meters (492 ft.) below the surface.

Alpine Folding Ends in Western Gard

In western Gard the Alpine system of folding which characterizes the structure of northern Hérault ends abruptly against the Central Massive of France and the bordering *Causses* of Jurassic limestone in the Tertiary basin of Alais. This is a long synclinal depression, elliptical in shape, with a major axis 60 kilometers (37 miles) long, trending about N. 25 deg. E., and a minor axis 10 kilometers (6 miles) long. The Tertiary basin of Alais began in the Eocene and was accentuated in the Oligocene. It is filled with a thick series of lagoonal and lacustrine Eocene and Oligocene beds, remarkable for the intercalation of formations containing the bones of mammals which permit determining the age of the beds and correlating them with those of other basins. On the east side the Eocene beds, resting on Urgonian and Barremian limestone, dip 20 to 45 deg. to the northwest. On the west the basin is cut off by a great fault trending N. 20 deg. E., which brings the Tertiary into direct contact with the Mesozoic.

To the southeast of the Jurassic plateau and the Tertiary basin of Alais in Gard extends a zone formed by folded Lower Cretaceous strata which has no especial geographic name. It is included between the Cévennes Fault, the valley of Gardon River, and the Tertiary syncline of Sommières. It is formed of low hills and plains traversed by a series of small brooks. The marly beds are well cultivated; the limestone beds are barren "*garrigues*" (heaths).

Folds Parallel Axes of Pyrenees

These folds, which extend across the Rhone into the Orange and Avignon districts, are parallel to the axes of the Pyrenées. All of the folds were denuded before the Oligocene so as to form a broad peneplain which extends from the Arrondissement of Alais into that of Uzès. The Sèyne fault, which brings up the massive of the Seere de Bouquet, is of later age than the Oligocene.

The St.-Just anticline appears to be the prolongation of that of Luberon in Provence. Its axis may be traced from Gardon River, east of Alais, eastward to St.-Just, thence east-southeastward to Belvezet. On its crest the Valanginian and Hauterivian beds are exposed. The St.-Just anticline is paralleled on the north at a distance of two kilometers or so by the Mons anticline, which may be traced eastward to Vallerargues. Valanginian beds are exposed on its crest. The Bouquet anticline extends from Bouquet, east of Nevacelles, east-southeastward to Lussan. The Fons-sur-Lussan anticline extends a little south of Allégre and Fons-sur-Lussan eastward to Le Roux. The Rochegude anticline trends eastward from Rochegude to Mejeannes-le-Clap. It is entirely formed of Urgonian beds.

These folds are crossed by a transverse fold bearing N. 20 deg. E., and extending from La Verrerie a little beyond La Leque. Structural domes occur near La Verrerie, Chabian, between Saussine and Rossière, and south of Font d'Higuet.

The lower valley of the Cèze is the eastern extension

of the broad Cretaceous basin of the left bank of the Rhone, known under the name of Uchaux Basin. The predominance of east-west folds at right angles to the course of the Rhone has oriented the smaller rivers in that direction. It is to this east-west orientation of these regions that the penetration of the Pliocene sea into the present river basins may be attributed.

South of the Cretaceous foothills of the Cévennes extends a low coastal region, at right angles to the valley of the Rhone. It is extended northward by the Théziers-Roquemaure depression. This region was originally filled with Pliocene sediments, and transformed by erosion into a low hilly country. The lower valley of the Gardon has cut deeply enough to expose the Miocene substratum.

The flat, marshy plains of the Rhone delta, usually known as the Camargue, are formed entirely of clayey and loamy sediments of late Quaternary age, brought down and deposited by the river.

Indications of Petroleum

A number of signs suggesting the presence of oil and gas occur in Lower Languedoc. Bitumen seeps from limestone apparently of Neocomian age in a railroad cut north of Milhaud, and at Connaux, 16 kilometers (10 miles) northwest of Uzès. The limestone, 1.15 meters (5 ft.) thick, is irregularly impregnated with bitumen, and does not appear to be rich enough for working. Maltha is also reported to seep out from the Neocomian at Mas du Chat, near Auzon. At Allègre, near Alais, occurs a bluish Neocomian limestone, from which bitumen seeps, in a manner similar to that of Seyssel, Department of Ain, which has been worked commercially for many years. Asphalt occurs in Albian or Cenomanian shale at Vagnas and elaterite at Laudun. Bitumen occurs in the Upper (?) Eocene at Barjac.

The chief asphalt-bearing formations of Languedoc, however, are in the Lower Oligocene, especially in the Infra-Tongrian or Lattorfian. An almost continuous series of outcrops of Lattorfian bituminous limestone along the east side of the Alais basin has been worked commercially for years. The outcrops extend from Servas on the southwest beyond St.-Jean-de-Maruéjols on the northeast. The limestone yields on an average 8.78 per cent of bitumen. From 15,000 to 25,000 metric tons of the limestone were mined annually before the World War. Since 1920, however, the yearly production has averaged only 5,000 to 15,000 tons.

Bitumen occurs also in the Chattian (Upper Oligocene) west of St.-Privat-des-Vieux. This deposit has not been worked commercially.

The most direct evidence of the presence of hydrocarbons in Languedoc, however, is an oil seepage near Gabian, in the Department of Hérault, about 15 kilometers (9 miles) southwest of Bédarieux and 20 kilometers (12½ miles) north of Béziers. The seepage, situated about half a mile south of the village of Gabian on the right bank of Tongue River, a tributary of Hérault River, has been known for centuries. The ruins of an ancient Roman bath, built over the supposed healing spring, still exist. At present the seepage no longer flows. This seepage issued at the contact between the permeable lower Triassic sandstone and the younger Triassic deposits, which include, in addition to a few beds of limestone resembling the German Muschelkalk (Middle Triassic), porous dolomite, variegated marl, and gypsum, which may be attributed to the Keuper (Upper Triassic), and form altogether an impermeable caprock. The seepage was apparently due to a local uplift, on the eroded crest of which the lower Triassic sandstone was exposed.

The density of the oil ranged between 0.882 and 0.894 (26.78 deg. and 28.93 deg. A.P.I.). A sample from a surface seepage, analyzed by Narcy, boiled at 250 deg. C., and yielded no light oils or kerosene, but good lubricating oil. In its ultimate analysis the crude oil showed 86.1 per cent of carbon, 12.7 per cent of hydrogen, and 1.2 per cent of oxygen.

History of Development

As early as 1608 the Gabian oil spring was known and utilized. The earliest written account of the seepage was a "Memoir on Some Peculiarities of the Lands of Gabian, and Chiefly on the Fountain of Petroleum Which Flows There," by Dr. Rivière, published at Montpellier in 1717.

According to Dr. Rivière, "The petroleum is collected every eight days, when it is put in a barrel. Here it is allowed to settle a few moments, so that the water may separate from it. The water is next emptied into the basin of the fountain through a hole in the bottom of a barrel, and when the petroleum commences to flow out it is run into earthenware vessels, where the separation is completed."

For more than eighty years after its rediscovery in 1608 the spring yielded each year 96 quintals (70 barrels) of crude oil. In 1717, when Dr. Rivière wrote, the tenant of the land on which the seepage was located had collected only 4 quintals (3 barrels) annually during the preceding twelve years. In the summer of 1715 the spring dried up, and remained dry for two whole months. But after the autumn rains it flowed just as before the drought. The spring was said to yield more petroleum at the equinox than at any other time; more also in summer, during mild, humid weather, than in the cold of winter.

Dr. Rivière in 1717 described the Gabian oil as opaque and deep brownish red in color. In a basin it appeared to have a slight greenish, strongly brownish cast. It has a strong, agreeable odor, similar to that of bituminous matter, and was inflammable.

In a memoir dated 1735 the Bishop of Béziers praised the medicinal properties of the Gabian petroleum. In 1752 Bovillet, a nobleman, equally vaunted the virtues of Gabian oil in his writings. In 1834 A. Hugo wrote: "The petroleum spring of Gabian is a well on which petroleum oil floats. It would appear that its flow is getting exhausted. At one time they collected 36 quintals (27 barrels) annually; in the last century the yield did not exceed 10 quintals (7½ barrels), and now no more than 80 to 100 kilograms (25 to 31½ gal.) are collected."

First Exploitation in 1884

No effort was made to exploit the oil spring until the latter part of the nineteenth century. In 1884 the Gabian Petroleum Co. was floated and soon began prospecting. Instead of drilling several small wells in different localities, which would have afforded a general idea of the succession of the strata, their strike, dip, points of outcrop, and general structure, the company began prospecting by a tunnel, 50 meters (165 ft.) long. As soon as these first trials had been made and evidence obtained that the oil seepage at Gabian was

fed by a petroliferous stratum, the Gabian Petroleum Co. began drilling in November, 1884, by the Dru free-fall system, under the direction of M. Zipperlen, a well 400 meters (1,312 ft.) south of the seepage. After drilling for ten months and obtaining shows of petroleum and cutting beds of bituminous shale, the well was stopped at a depth of 203 meters (666 ft.). It had an initial diameter of 40 centimeters (15.75 in.) and terminated with a diameter of 25 centimeters (10 in.). It was cased to a depth of 170 meters (557 ft.).

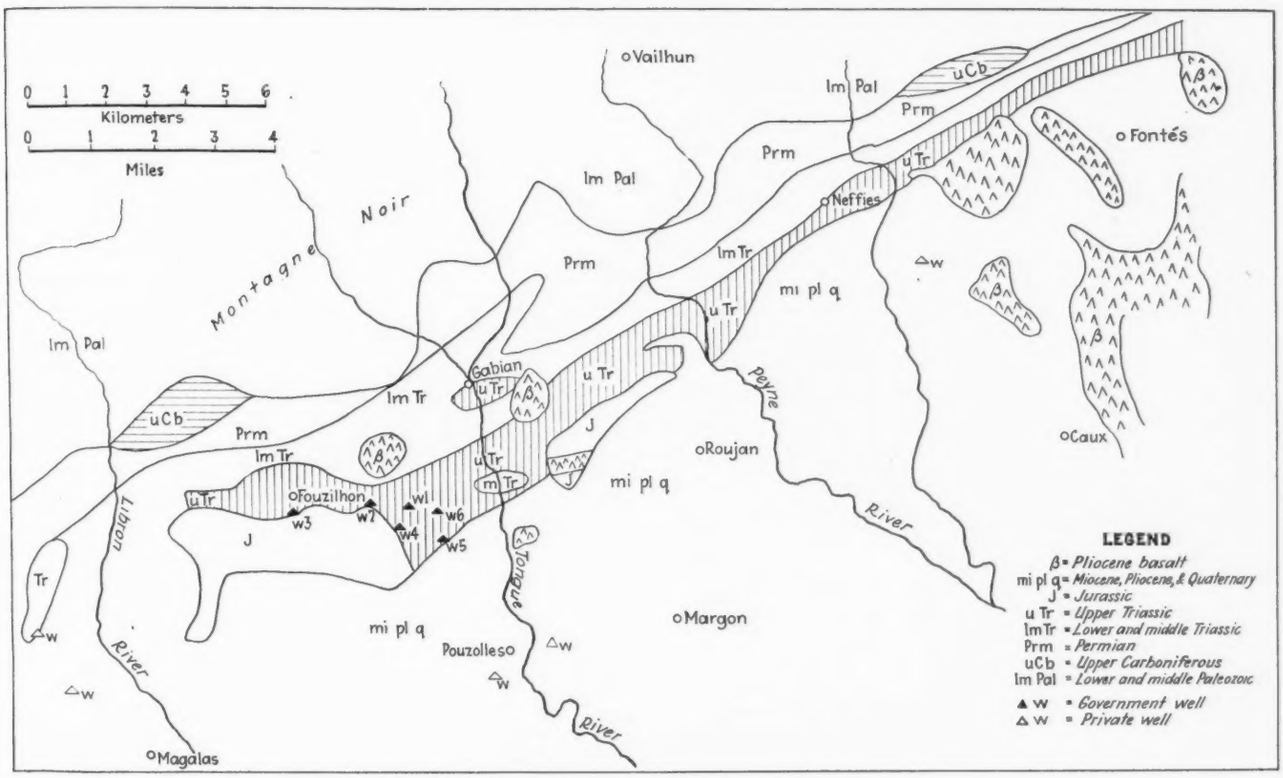
After the abandonment of the first well M. Zipperlen started in 1886 a new well at a distance of 900 meters (2,952 ft.) to the north of the first well. The Canadian system of drilling was used. In four months 413.35 meters (1,354 ft.) was drilled. The well was begun with a diameter of 30 cm. (11.8 in.), and was cased to a depth of 315 meters (1,033 ft.), with a final diameter of 13 cm. (5 in.). It was drilled on rising ground, apparently representing an uplift. After the first few meters, beds supposed to be Permian, but probably Triassic, were struck. Traces of petroleum were met. The well passed through the Permian (?) conglomerate, sandy limestone, and dolomite, through 15 meters (49.2 ft.) of Devonian (?) dolomite into hardened and partly altered older Paleozoic beds in which it was abandoned.

From a geologic standpoint these two wells were poorly located. The first well, south of the seepage, was in a syncline of Upper Triassic beds. The second well, north of the seepage, was drilled directly in the outcropping Lower Triassic sandstone, which at that place had no caprock to retain the oil.

For thirty-nine years the Gabian seepage was neglected and almost forgotten, until the reawakened interest in petroleum which followed the World War led to the examination of many old seepages. In 1923 an official mission, organized at the instigation of the Geologic Section of the Comité Scientifique du Pétrole, Direction des Pétroles et Essences, was sent to prospect the Gabian area. Louis Barrabé and Pierre Viennot, geologists, advised drilling at Gabian and suggested two approximate sites. Drilling was begun in August, 1924, under the direction of M. Viennot, his colleague, M. Barrabé, having gone to Madagascar on a prospecting errand.

First Well Brought in Nov. 6, 1924

The first well was located 1,500 meters (4,920 ft.) southwest of the former seepage, on the apparent southwestward extension of a dome of Triassic strata exposed in the bed of Tongue River. Cores extracted at



Sketch-map of the Gabian oil field. After Barrabé

depths of 95.3 meters (313 ft.) and 96.7 meters (317 ft.) were impregnated with petroleum. Precautions were taken to shut out water; on Sept. 11, 1924, when the well was tested for water-tightness, about 40 liters (10 gal.) an hour of petroleum seeped into the well. As the well was slowly deepened, reaching 105.75 meters (347 ft.) on Oct. 31, the seepage continued at the rate of 5 to 40 liters (1¼ to 10 gal.) an hour. On Nov. 6, 1924, at a depth of 106.75 meters (350.2 ft.) an initial flow of 1,000 liters (264 gal.) per hour was struck; this decreased to a steady output, both by flowage and by pumping, of 500 to 600 liters (3¼ to 3¾ bbl.) per hour, and finally to 2 or 3 cu.m. (14 to 19 bbl.) a day.

The first well passed through the Upper Triassic cavernous dolomite and gypsiferous marl. Cores taken at intervals from a depth of 95 meters (312 ft.) down showed that the productive beds consist of alternating cavernous dolomite and sandstone containing dolomitic grains and quartz pebbles, belonging to the transition zone between the Upper and Middle Triassic dolomite and marl and the Lower Triassic sandstone. Stratigraphic studies show that this transition zone is about two

hundred feet thick and contains intercalated beds of impervious shale; other petroliferous beds may exist at greater depth. Production was apparently obtained from the Lower Triassic sandstone. The "mother rock" of the petroleum accumulation is believed by Barrabé and Viennot to occur in the underlying Paleozoic. Joleaud places it in the Permian oil shale measures or even in the Coal Measures of the Upper Carboniferous.

The accompanying gas, which occurs under sufficiently strong pressure to cause the wells to flow, and issues from the well in the form of an emulsion, consists of almost pure carbon dioxide. This gas, apparently of volcanic origin, is given off at several places in the vicinity.

A second well, drilled 500 meters (1,640 ft.) west of the first well, was flooded by artesian water, and abandoned at a depth of 334 meters (1,096 ft.). The third well, located 1,500 meters (4,921 ft.) west of the first well, likewise was flooded by water and abandoned at a depth of 350 meters (1,148 ft.).

Well No. 4, situated only 150 meters (492 ft.) south-southwest of No. 1, came into production on Aug. 23, 1925, at a depth of 144 meters (472 ft.) in a dolomitic breccia, after going through the Upper Triassic marl and gypsum. The initial production was 100 metric tons (747 barrels) daily; this decreased to a steady production of 15 to 20 cubic meters (101 to 136 barrels) a day. In the first six months of 1926 it yielded 2,000 cubic meters (12,580 barrels) of oil; at the end of July, however, it had been nearly drowned out by water.

The fifth well, located 380 meters (1,247 ft.) east-southeast of No. 4, passed through the Upper Triassic gypsiferous marl into the dolomitic breccia but struck a flow of artesian water at a depth of 216 meters (708.7 ft.) and was abandoned.

Well No. 6, drilled 300 meters (984 ft.) east of No. 4, by a combined Pechelbronn rig, gave oil at a depth of 167.5 meters (549.5 ft.) under stronger gas pressure than the others; nevertheless the oil has had to be pumped and bailed out. The initial yield was 60 metric tons (448 bbl.) in forty-eight hours; the settled production was 16 cubic meters (100 bbl.) daily. In the first five months of 1926 the well produced 1,700 cubic meters (10,603 bbl.) of oil.

Four more wells were drilled in the spring of 1926 in the area reserved by the government, to depths of 200 to 270 meters (656 to 886 ft.). All were unsuccessful, yielding only water.

The following table illustrates the rate of output of the three present producing wells:

Crude Petroleum Produced at Gabian, 1924-1925, and Two Months of 1926[a]

In barrels of 42 U. S. gallons

Year	Well No. 1	Well No. 4	Well No. 6	Total
1924	1,396	....	....	1,396
1925	4,384	8,806	....	13,190
2 months 1926	289	1,604	692	2,585
Total	6,069	10,410	692	17,171

a Courrier des Pétroles.

The crude petroleum produced at Gabian is dark brown in color, with a greenish fluorescence. Its density ranges between 0.8000 and 0.8464 (35.7 deg. and 45.4 deg. A.P.I.) at 15 deg. C. It contains 10.35 per cent of paraffine and only traces of asphalt, is quite viscous below 18 deg. C., and jells below 17 deg. C. It yields on distillation below 225 deg. C. 3.95 per cent of gasoline and 26.05 per cent of kerosene. By "cracking" it may be made to yield 48 to 50 per cent of gasoline. The oil is loaded into tank cars and shipped to the refinery of the Compagnie Industrielle des Pétroles, situated at Frontignan.

Private Capital Now Drilling

Private capital has also been active in testing the Gabian area. The Société de Péchelbronn in May, 1926, had drilled one unsuccessful well just south of Pouzolles to 387.6 meters (1,270 ft.) in the Devonian, and had put down a second well 370 meters (1,214 ft.) in the Miocene.

Near Magalas the Société Financière et Coloniale drilled three unsuccessful wells; one to a depth of 316 meters (1,037 ft.) in the Miocene; a second well to a depth of 396 meters (1,299 ft.) through the Miocene and into the Upper Triassic dolomite and shale; and a third well 370 meters (1,214 ft.) deep into the Middle (?) Triassic dolomite.

East of Neffiès the Société de Recherhes de Minerais et d'Hydrocarbures drilled on an apparently well-located site 450 meters (1,476 ft.) through the Miocene Upper Triassic, and Lower Triassic into the Permian without obtaining more than a strong smell of oil at 295 meters (968 ft.) and an outburst of carbonated water at 343 meters (1,125 ft.). Southeast of Pouzolles the Société Alsacienne et Lorraine de Recherches Minières drilled unsuccessfully. East of Magalas the Société Le Pétrole de France put down an unsuccessful well 310 meters (1,017 ft.) in the Miocene. Northeast of Gabian, near Fos at the foot of the Montagne Noire, M. Nègre, an engineer, drilled 95 meters (312 ft.), and ended without success in Carboniferous shale. At Lezignan-la-Cèbe, northeast of Pézénas and 20 kilometers (12½ miles) from Gabian, Colonel Rimailho drilled to a depth of 132 meters (433 ft.) in the Miocene without striking oil or gas.

Conclusion

It would be easy to exaggerate the importance of the Gabian discovery. The amount of crude oil so far produced is very small, according to American ideas. Nevertheless, it shows that at least a small pool of commercial size exists at shallow depths at Gabian, and suggests that others of equal or perhaps greater productivity may be found by drilling in the structurally favorable parts of Lower Languedoc. Although the Mesozoic beds south of Gabian are in general monoclinal, dipping to the south-southeast, it is quite possible that other less pronounced anticlinal folds in addition to those already noted are present, and it is not too much to suppose that petroleum may be struck at least at some places on these anticlines beneath a caprock of Upper Triassic.

Farther to the south beneath the broad Miocene and Pliocene mantle which covers the older formations from a little south of Gabian to the sea, geologic study unaided can give no precise information on the structure of the Triassic, as this must in the nature of things be different than the younger, unconformably overlying Tertiary beds. Nevertheless, a campaign of deep drilling or perhaps of geophysical prospecting would indicate the depth and attitude of the Triassic in this region and at the same time give good chances of discovering commercial pools of oil or gas. Such accumulations would undoubtedly be deeper than those near Gabian, but they would probably be from that very circumstance much more productive. According to American experience

the virtual absence of surface indications proves nothing as to the presence or absence of oil.

The oil industry and the public may well await with interest the results of future prospecting and drilling in Lower Languedoc.

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How Electric Shot Firing Developed

Gunpowder was probably known in the thirteenth century and used in firearms in the early part of the fourteenth century, states the U. S. Bureau of Mines, in a recently issued report. For more than 500 years after the development of gunpowder, the only means of igniting it was by sparks from flint and steel or by an open flame; therefore, quantities of powder could not be safely fired unless the explosive energy was directed as in a gun or cannon. Application of powder to industrial uses was consequently limited by the hazards which attended its use.

The introduction of electric shot-firing was a decided advance in the use of explosives, as it made their use safer and wider. Shots could be fired from distant points and through submerged circuits; also, several shots could be fired simultaneously.

Perhaps the earliest attempt to ignite powder electrically was made in America, when Benjamin Franklin, as early as 1751, had considerable success, using electrostatic sparks.

Other scientists, among whom were Priestly and Wolff, tried to ignite powder electrically, but the work remained experimental until the nineteenth century. One of the first practical applications of electric shot-firing was made in 1812 by a Russian nobleman, Baron Schilling, who, during his work on military telegraphy in Russia, succeeded in insulating conductors and firing, by means of a Leyden jar, charges of gunpowder across the Neva River at St. Petersburg, which suggested great possibilities of electric shot-firing in warfare. Later, Baron Schilling gave demonstrations of his achievement in France and in Germany. He fired powder charges not only at a considerable distance but across stretches of water. Further development was greatly handicapped by the lack of a more suitable source of electricity, as Leyden jars and electrostatic machines were the only sources then available. Therefore, the first marked advance in electric shot-firing came after the development of the primary cell and discovery that an electric current from these cells could be made to heat a short piece of resistance wire used as part of the circuit.

Powder was ignited by means of a primary cell as follows: The small piece of resistance wire in the circuit was embedded in the powder charge that was to be exploded. When the current was applied, the heat from the resistance wire ignited the powder.

Electric shot-firing was further improved by the discovery in 1847 of a practical way to insulate electric conductors, so that powder charges could be ignited without leakage of current and shot-firing machines could be made that were not greatly affected by moisture. Later, about 1850, the development of the spark gap and modern high-tension igniters made possible the ignition of explosives from great distances.

An historical résumé of the development of electric shot-firing is contained in Bulletin 240, "Electric Shot-Firing in Mines, Quarries, and Tunnels," copies of which may be obtained from the Bureau of Mines, Department of Commerce, Washington, D. C.

Useful Operating Ideas

Liquid Starters at Mines

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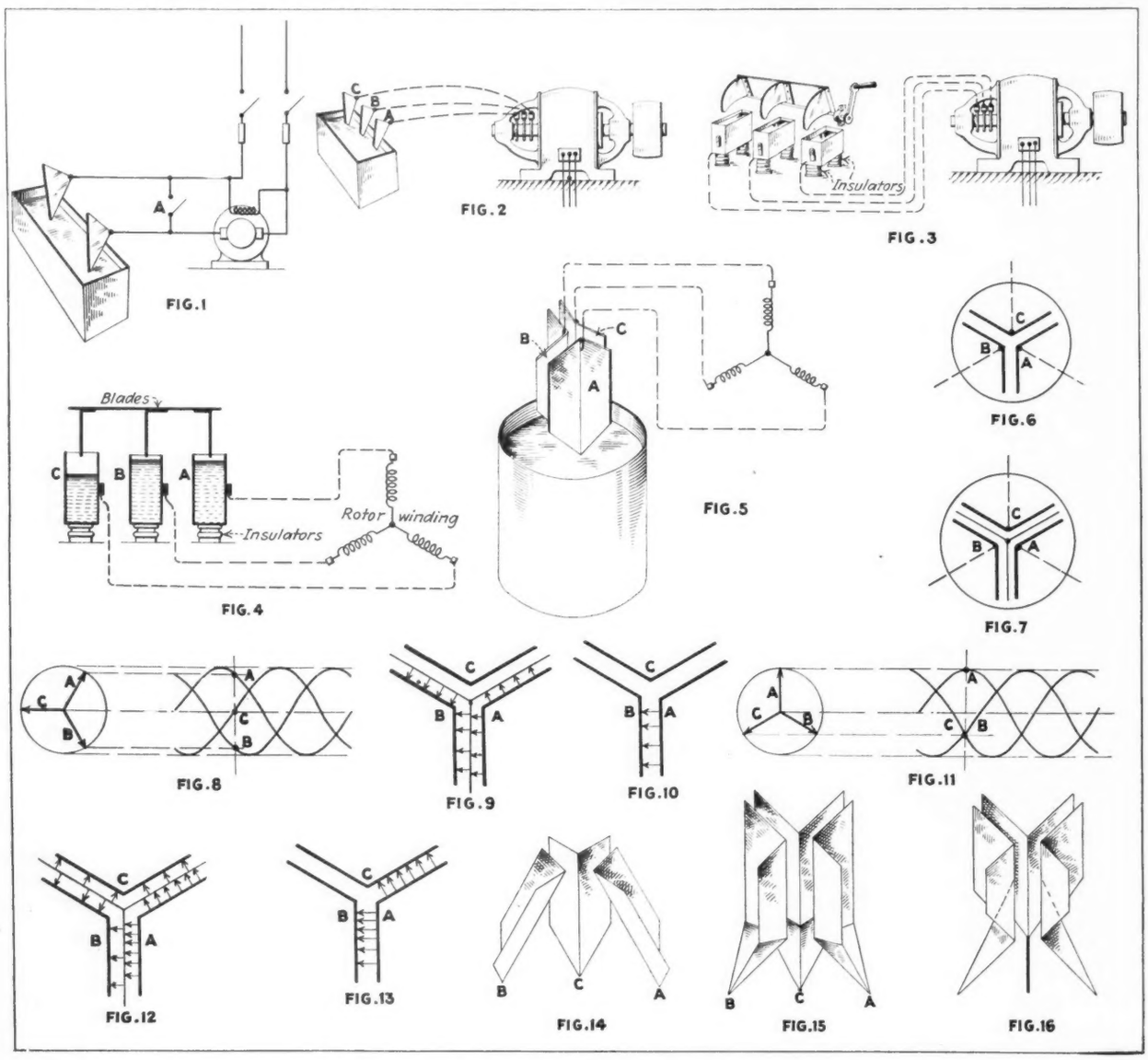
THE requirements of a workable liquid starter for slip-ring motors (three-phase motors with wound rotors) are: (1) To function at all times and give any desired acceleration—the amount of resistance or current flow in each rotor lead to be the same; (2) simplicity with the minimum number of parts; (3) low initial cost and low maintenance cost.

The necessity of installing promptly five large ball-mill motors that arrived without starters at a remote mining camp compelled attention to be given to the devising of a liquid-starter equipment for them. The step by step process finally developed one type of liquid starter that may prove interesting, and therefore a description of the advantages and disadvantages of other types is briefly given.

Fig. 1 shows the principle of the common type of liquid started that works successfully in an emergency on a direct-current circuit. Only two blades are necessary and they are connected so as to give the rheostat effect to the armature of a direct current motor. Switch "A" is closed when the motor attains full speed.

Fig. 2 illustrates a three-phase motor with three blades connected to leads from the slip rings of a wound rotor. When the blades are dipped into the solution the amount of current flowing from blade to blade will not be the same, which condition results from the unequal resistance between all three blades. The current in the



Figs. 1 to 16 inclusive—Types of liquid starters

rotor circuit is not balanced across all three phases. This can be proved by referring to the arrangement of the blades. The greater part of current will flow between *A*—*B* and *B*—*C*, but only a small part between *A*—*C*. The blade *A* has a short path to *B* but a long path to *C*; likewise, *C* has a short path to *B* but a long path to *A*. On a breakdown test, the short-circuiting flash-over would be across only *A* and *B* or *B* and *C*, but never across *A* and *C*. To overcome this unbalanced condition, certain foreign manufacturers designed the three-tank type of starter. In this case, three tanks are connected to the slip-ring leads and insulated from one another as shown in Fig. 3. The movable blades that are connected together form the electrical path from one tank to another. This type of controller is in extensive use, especially at Johannesburg (South Africa) gold mines, where slip-ring type motors are favored. However, the three-tank type of controller works balanced only under favorable conditions and these are not maintained in general practice. A perfect balance in such a starter is attained only when the liquid is of equal density in each tank and when the liquid in each tank is the same in quantity and is at the same level so that all blades touch the liquid at the same instant.

It is difficult to maintain the foregoing conditions, as the liquid evaporates at a different rate in each tank. By adding fresh solution to the tanks from time to time, the density of the solution in the three tanks will vary. The result is that the motor is brought up to speed in an unbalanced manner. For starters working under heavy loads, such condition will cause sparking, spluttering, and steaming of the liquid, and when a motor has to be brought up to speed on a 100 per cent overload at starting, the liquid in the three tanks will have different levels before the motor has attained full speed. In some cases one of the three tanks may be boiled or spluttered almost empty.

Further, when starting up a motor on a very heavy overload (using a starter rated for normal full load starting torque), if the tank solutions are not all at the same level, the blades will not dip into the three tanks at the same time, and the load will come upon one phase as shown in Fig. 4. Fig. 4 shows that tanks *A* and *B* connect one phase, *A* to *B*, but the other two phases, *B* to *C* and *A* to *C*, are open. Later when the blade touches the solution in tank *C*, violent sparking takes place in that tank, but not in tanks *B* and *A*, as the blades in them are well immersed in liquid. The sparking and spluttering in tank *C* will reduce the quantity of liquid still further. Moreover, in this case the motor is brought up to speed in an unbalanced manner, which reduces its efficiency.

Special Blades Patented

I secured a patent in 1915 on an invention of a special arrangement of blades, to be used within a single solution tank, such that a balanced condition for all three phases can be obtained at starting, regardless of the strength of the solution or quantity of solution. There are two types. For small motors the type shown in Fig. 5, without the neutral center plate, can be used. With this blade shape, as shown in plan in Fig. 6, the resistance between the blades *A*, *B*, and *C* is equal. One-half of the surface area on blade *A* forms a path to *B*, the other half forms a path to *C*, and likewise one-half the surface area of *C* forms a path to *A* and the other half to *B*.

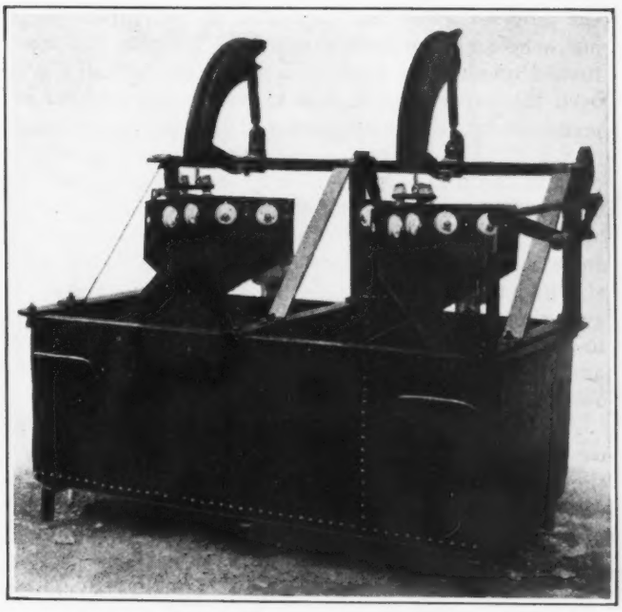


Fig. 17—Liquid starter for simultaneously starting two jaw-crusher motors

The other type is similar in every respect except for an additional plate in the center, as shown in Fig. 7. This center, or neutral, plate increases the efficiency of the starter 100 per cent. The current flow in the liquid circuit can be shown by the aid of a clock diagram and three-phase sine wave, Fig. 8. At the instant when the current in line *C* is zero the current in line *A* will equal the amount in *B*. The current from blade *A* to blade *B* takes the path through the liquid as shown by the small arrows in Fig. 9. The neutral blade acts as a conductor to collect the current from the total area of blade *A* and to distribute to total area of blade *B*. Without the neutral plate only one-half the area of blade *A* and blade *B* would be active, as shown in Fig. 10.

By the aid of sine wave diagram in Fig. 11 the advantages of the central neutral blade can be further understood. At the instant when the current in line *A* is equal to the sum of the currents in lines *B* and *C*, the direction of the current flow through the liquid is represented, in proportion, by the small arrows in Fig. 12. Without the neutral blade, only half of blade *B* would be active, as shown in Fig. 13, and only half of blade *C* would be active.

This type of liquid starter has proved a success at several mining properties in Nevada. Where heavy loads, such as 150-hp. ball-mill motors, are to be started and moved only a fraction of a revolution, as for the purpose of raising the manhole to a desired position for repairs to liners, the liquid starter will control the current flow so that it increases gradually from zero to maximum and decreases from maximum back to zero gradually or almost instantly, as desired. No matter how fast the blades may be submerged, the current will rise from zero to maximum at a uniform rate, or, if the blades are only partly submerged, the current will flow from zero to any desired point within the maximum. This advantage can be appreciated only when compared with the compensator, with its 50 per cent or other middle taps. The inrush of current is not gradual but sudden.

When a ball mill has been at rest for a few hours

the pulp settles at the bottom of the mill in a compact mass, holding the balls rigid until the mill has almost turned one-half of a revolution. In some cases it has been the experience of mill men that the highest compensator tap did not supply the motor with enough power to turn the mill over. The current is switched off and the mill is permitted to swing back, and when on its forward swing the current is switched on again, and in this way the mill can be brought up to speed. In some cases it was necessary to switch the motor across the line to get going. Switching off the current and swinging the ball mill to get going is disastrous to the finger contacts of the compensator, as the kilovolt-ampere factor, with its large proportion of wattless current, is a maximum during the starting period.

Another objectionable feature of compensators, when connected on the highest taps, is the jolt or bump on the transformers or power system when starting excessive loads. The gears, pinion and pinion bearings undergo a similar jolt at starting. The ideal would be to follow the practice that gives the smoothest acceleration as exemplified in electric railway, street-car, hoist, and other similar controls. Power in each application is gradual through many stages from zero to maximum.

The arrangement of the blades for minimum current flow at starting is shown by Figs. 14, 15, and 16. In Fig. 14 the three blades are hinged on top to insulators and the lower ends spread so as to obtain the increased resistance of the liquid due to a longer path for the current to flow between *A*, *B*, and *C*. As the blades are submerged in the liquid, they are brought closer together, thereby reducing the resistance as well as increasing the surface area of the blades submerging in the liquid.

In Fig. 15 the blades are represented fixed in respect to spacing, but the lower tips are so designed that the resistance is a maximum between phases when the tips touch the liquid. In Fig. 16 the blades are represented with fins tapering down, so that the tips are a maximum distance apart and the minimum area is in liquid when starting. Representation of the neutral center blade is omitted in Figs. 14, 15, and 16 for the sake of clearness. There are two methods of operating this particular type of blade: by lowering the blades into the liquid, or, in the case of stationary blades, by raising the liquid at any desired rate of speed and to any desired height. For hoist service it is necessary to use a larger quantity of liquid and a cooling coil. For large hoists the liquid is cooled in a manner similar to that used in water-cooled transformers. For the sake of clearness in all of the accompanying sketches, the short-circuiting of the rotor circuit, when the motor attains full speed, is not shown.

A starter of special construction for duplex control is shown in Fig. 17. In this case an exceptional large jaw-crusher was to be driven by two motors, the starting of the two motors being accomplished by operating one lever. The liquid solution was common to both starter blades and the tips touched the liquid at the same instant when starting. It worked like a charm.

Carrying Case for Capped Fuses

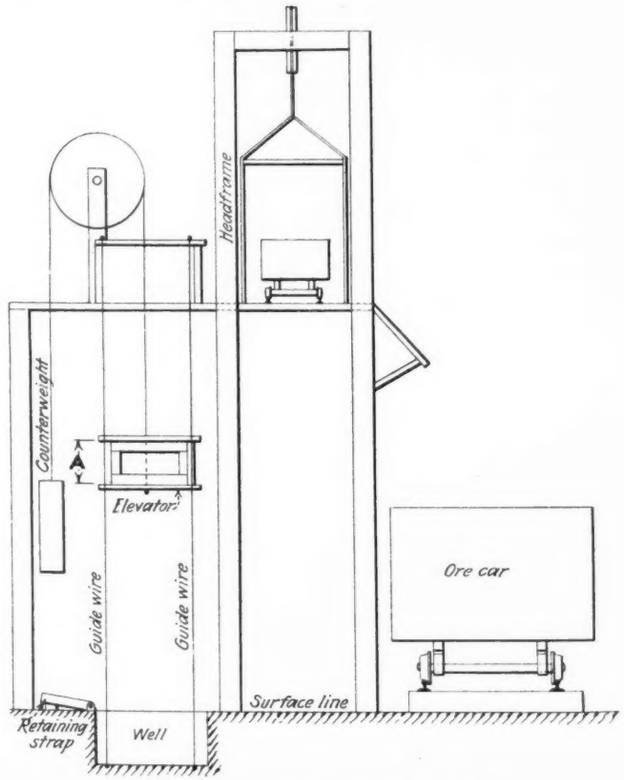
The Penn Iron Mining Co., Vulcan, Mich., has adopted a special carrying case for capped fuses. It was devised for miners who have to carry their capped fuses or primers through raises or small openings. The general practice is to coil the fuse in a roll and stick it over the forearm. Where a steep ladder is to be climbed there is danger of bringing the primers in contact with the miners' lamp or of striking them against some piece of rock or metal.

The carrying case is made of heavy galvanized iron, is 9 in. in diameter and 3 in. deep with a flange 1 in. deep around the top, and has a hinged cover which also is 1 in. deep. The entire case is lined with heavy felt and a soft rubber band is placed around the inside edge of the flange. In this way there is no metal exposed which the caps can touch during transportation. The case is carried over the shoulder by means of a strap, and does not impede a person climbing ladders.

A Labor-Saving Man Elevator

By Carl Trischka
Bisbee, Ariz.

Where ore cars are dumped into a railroad car and it is necessary for the hoisting engineer to act also as shaft topman, both time and effort can be saved by the use of a simple type of man elevator shown in the accompanying illustration. The elevator is placed at a point convenient to the cage landing and also to the hoist. It consists of a platform constructed of 2x12x24-in. board. The dimension "A" should be such that the platform will not tilt or bind. The platform is held in place by guide wires which are provided with turnbuckles so that they may be kept tight. A light wire rope connects the elevator platform with a counterweight which slightly exceeds the weight of the platform plus the weight of the man. When the platform is in its lowest position it is held by a retaining strap or catch. The excess weight on the counterbalance side lifts the man. The downward trip is accomplished by pulling upon the guide wires.



Man elevator for use at mine shafts

News of the Week

Summary

ROEBLING mineral collection a gift to Smithsonian —Magnesite duty sought—Silver purchase recommended by House committee.

Tom Reed to resume at Oatman property—Verde Central installs heavy pumps—C. & A. ships 75 cars of acid per month.

New Brunswick revising mining laws—Newfoundland lead-zinc deposit under development.

Coeur d'Alene companies adopt life insurance plan for employees.

George Graham Rice enjoined from sale of Colombia Emerald stock.

Tungsten Production Co. increases milling capacity.

Mexican Congress reduces tax on silver; many new plants started during year; labor troubles at Dos Estrellas settled; Boleo operations to be increased.

Burma completes satisfactory year—Bawdwin mines increase operations—Manganese and iron production increase in India while petroleum declines.

Interstate Zinc & Lead Co. formed—Quapaw Indians recipients of large royalties—Anselmo property passes to Anaconda.

Subsidence at Michigan mines under investigation by Bureau of Mines.

Platinum reported in Rouyn—Teck-Hughes has better ore on deeper level.

Utah Copper Breaks Records—Loads 55,300 Tons Ore Per Day

Shovels Electrified; Oil-Electric Locomotive on Trial Runs; New Townsite Established

THE year 1926 was one of major achievement for the Utah Copper Co., including the electrification of the shovels formerly operated by steam; the initial electrification of its transportation system, and the founding of the model community of Copperton. From the standpoint of metal production and tonnages of ore mined, shipped and milled, all records were broken. Dividends were increased to $1.50 a share during the fourth quarter.

The net output of copper for 1926 will reach a total of approximately 235,000,000 lb., compared with 214,592,733 lb. for the previous high of 1924. On Nov. 19, 55,300 tons of copper ore was loaded and shipped, which excels anything ever done before in one day. On June 22 all records for the loading of ore and waste were broken, when 107,000 tons was handled.

Previous mill records were also exceeded on Nov. 19, when 48,400 tons of ore was treated. Average daily tonnage treated by the mills of the company for one month was also broken when during November a daily average of 45,500 tons was made.

Housing Facilities Improved

Realizing that the efficiency of a corporation depends largely upon the loyalty of its employees, the Utah Copper Co. has gone into the business of providing living facilities for its men that could hardly be surpassed. Congestion at Bingham was such that living conditions were far from ideal or even average, and each day more space for dumping is needed. At the mouth of Bingham canyon, about two miles from the mine, there is ample space for living, pure air, and abundant sunshine. Eighteen houses, ranging in size from four to nine rooms, have recently been completed. This constitutes the first unit of Copperton. Twenty more of these comfortable brick bungalows are to be built during 1927.

Wherever practical, copper and brass have entered into the construction of Copperton. Copper shingles, copper gutters, copper downspouts, and copper smokestacks have been installed. All plumbing is of brass. Building expense has been increased but 5¼ per cent, or an average of $310 per building, by the use of these metals in the place of cheaper substitutes. Hundreds of hardwood trees have been planted around the houses and in the park. A wading pool for children, a playground, a large ball park, and other recreational features are provided.

For the purpose of testing electric haulage in competition with the steam, the company has installed at the mine one oil-electric locomotive. A trolley electric locomotive has been ordered and will be installed soon. If these prove more economical than coal-burning locomotives, it is probable that the whole Utah Copper and Bingham and Garfield railroad system may be electrified.

New townsite of Copperton, Bingham Canyon, Utah

Tom Reed to Resume at Oatman Property

The Tom Reed Mining Co. has decided to resume operation of its property at Oatman, Ariz. For the last few years the property has been operated by Jack Shank and associates, who have produced about $1,000,000 during the life of their lease. Most of this has come from the Aztec and Ben Harrison mines.

Since the mine was first opened up a total of $14,000,000 in gold has been mined. It is the successful operation of the lease that has convinced the company that the Tom Reed is still a potential big producer. Mr. Shank will be in charge of the work for the company and expects to start operations with a force of 35 men.

Verde Central Installs Heavy Pump Column

One of the heaviest of pump columns has been set in the shaft of the Verde Central Mines Co. at Jerome, Ariz. It is 1,900 ft. in length and weighs 53 lb. to the foot and consists of sectional 6-in. wrought iron, with walls nearly 1 in. thick. This pump installation will handle all the water of the mine. The flow is not heavy and appears to have little effect upon the municipal supply, secured in the limestone about a mile above the Verde Central shaft. Reports from the mine are to the effect that new smelting ore is being developed on the 600 level.

C. & A. Ships 75 Cars of Sulphuric Acid per Month

The Calumet & Arizona Mining Co.'s sulphuric acid plant at Douglas, Ariz., is shipping 75 carloads of acid per month to the new leaching plant at Inspiration. One 50-ton carload a day is being used by the New Cornelia Copper Co. at Ajo. The acid plant was erected at a cost of $1,000,000 and has a capacity of 200 tons per day.

Anselmo Passes to Anaconda

Anaconda Copper Mining Co., according to announcement by J. R. Hobbins, vice-president, has purchased all the outstanding interests not heretofore owned by it in the Anselmo Mining Corporation. This includes a 50 per cent interest owned by International Minerals & Metals Corporation, of which J. C. Colgate and Benno Elkan, of New York City, are the leading factors. The Anselmo group lies in the west-central part of Butte and is opened by shaft 2,800 ft. deep. The Anselmo company was organized in 1917 to take over twelve claims, the Anaconda company purchasing a half interest in 1920. Two hundred men are employed at the property.

Quapaw Indians Recipients of Lead-Zinc Royalties

Individual restricted Indians of the Quapaw reservation, in northeastern Oklahoma, reaped a harvest of royalties amounting to $1,679,836 from the production of lead and zinc on their lands last year, according to the Interior Department. This represented an increase of $422,717 in royalties over the previous year. Lead and zinc mined on the allotments of these Indians during the year was 289,622 tons, compared with 259,432 for the previous year, a gain of 30,190 tons. The gross value for last year was $17,672,498, against $15,135,569 over the previous year, the increase being $2,536,929.

Incomes of a number of the Indians from their lead and zinc properties ran into thousands during the year. One of the largest was that received by Anna Beaver Bear, who received $220,755 in royalties. The second largest individual income for the year was received by Robert Lottson from his allotted land, the total being $165,454. Benjamin Quapaw, another member of the Quapaw tribe, was paid $87,346 in royalties during the year. Many other members of the tribe received royalties ranging from $1,000 up to $10,000 for the year. There are all told forty-three Quapaw Indians with allotments where lead and zinc is being mined on this reservation.

Inter-State Zinc & Lead Co. Formed

Active mines valued at between $3,000,000 and $4,000,000 in the Joplin-Miami district were involved in the most notable amalgamation of mining properties in that field's history, consummated at Kansas City, Mo., on Dec. 31. Properties involved included the Velie-Lion, the Hutcheon, the Cherokee Lead & Zinc, the Meteor, and the Oklahoma Woodchuck. In addition there was valuable acreage in the Baxter Springs, Kan., district, owned by the Velie Mines Corporation, and the forty-acre lease of the Townsite Mining Co., which is located in the Cardin townsite. The new concern growing out of this amalgamation is to be known as the Inter-State Zinc & Lead Co., and it is understood it will be capitalized or bonded at from $10,000,000 to $12,000,000.

The five properties included in the deal produced a total or 44,000 tons of zinc and lead concentrates during 1926, valued at close to $3,000.000. It is expected that R. M. Atwater, Jr., president of the New York concern which owns the Oklahoma-Woodchuck mine, in this field, will be president of the Inter-State Zinc & Lead Co., and C. F. Dike, of Joplin, is to be general manager.

Simon Silver-Lead Milling 250 Tons Daily

The Simon Silver-Lead Mines Co., operating at Simon, Nev., has about 120 men on surface and underground work, and is milling 250 tons per day in its flotation plant. Mine conditions are said to be good and the main shaft is to be sunk from the 850 to the 1,000 level. On the 800 level the orebody has a maximum width of 80 ft., and conditions are regarded as favorable with depth. The Simon ore is a low-grade silver, lead, zinc ore, and two concentrates are produced in the mill—lead-silver and zinc-silver. The mill product is hauled to Mina for shipment to Utah smelters.

Ray Mines Will Buy Power from Roosevelt Dam

Through a contract recently closed between the Nevada Consolidated Copper Co., successor to the Ray Consolidated Copper Co., and the Salt River Valley Water Users' Association, the farmers of the Salt River Valley will realize an annual income of $250,000 from the sale of power to the mining company.

The contract which provides for the sale of power by the association to the Ray mines and Hayden smelter will add about $1 an acre per year to the power income already enjoyed by the farmers who constitute the association. The new contract will become effective about May 1, 1927, with the completion of the Horse Mesa dam, now under construction, and will bring the total annual income from power sales up to $2,500,000.

Phelps Dodge Gets Patent to 160 Mill Sites

What is believed to be the largest patent ever issued in Arizona was recently received at the United States Land Office at Phoenix. This patent transfers 160 five-acre mill sites to the Morenci branch of the Phelps Dodge Corporation, formerly the Arizona Copper Co.

Years ago the copper company disposed of its tailings from mine and mill by running them into the San Francisco River, which is a tributary of the Gila River. Farmers in the Gila Valley objected, stating that the tailings were ruining their lands, and in 1908 the then Arizona Copper Co. was enjoined from disposing of its tailings in this manner. Being deprived of this means of getting rid of its waste material, the company was forced to acquire land on which to put it and the patent recently issued is the result of its efforts. The mining company spent $5 an acre, or a total of $4,000, in acquiring the 800 acres on which to build a tailings dam. The grant is subject to the mining laws of the state.

Forty-three Fatalities at Arizona Mines in 1926

The fifteenth annual report of the Arizona State Mine Inspector, for the year ended Dec. 1, 1926, shows that there were 43 fatal accidents in the mines of the state during that period. A total of 14,368 men were employed in Arizona's 132 mines during the year, so that the fatal accident rate was three deaths for each 1,000 men employed. Serious and minor accidents, exclusive of those resulting in death, numbered 792.

Portland Gold Discovers Rich Oreshoot

The Portland Gold Mining Co. has discovered a large oreshoot on the 2,600-ft. level at Victor, Colo. A drift extending the main vein has opened up a body of ore assaying high in gold. The ore has been opened in absolutely virgin ground, and from the geology it is reasonable to suppose it will extend well toward the surface.

News From Washington

By PAUL WOOTON
Special Correspondent

Bureau of Mines Fast Becoming Service Agency—Silver Purchase Recommended by Committee—Proposed Change in Potash Act

With the prospects favoring the voting of a large sum for the helium program of the Army and Navy, it seems likely that the appropriations for the U. S. Bureau of Mines for the next fiscal year will be around $5,000,000. In the helium work, however, the Bureau of Mines simply acts as the manufacturing agent for the War and Navy Departments. This raises the question that the Bureau's activities on behalf of the mining industry are likely to be overshadowed by these service functions.

In addition to the helium work, the Bureau of Mines is operating the government fuel yards. It is analyzing all of the coal purchased by the government. Its oil-shale work is largely service for the Navy. The fear is expressed that the tendency to unload service jobs on the Bureau of Mines may create the impression that the Bureau's total appropriation is to be applied for work in behalf of the mining industry. As a matter of fact the mining industry is treated more shabbily in this budget than ever before. Though Senator Oddie, assisted by other Western Senators, is doing his utmost to provide for the beginning of certain activities which would be very beneficial to the industry, there still is no assurance that approval for these additions can be secured.

Silver Purchase

Purchase of 14,589,730.13 fine ounces of silver at $1 an ounce is recommended by the Banking and Currency Committee of the House of Representatives. The bill making this provision was passed by the Senate June 8, 1925. Because of a division in the House committee it has taken this long to bring the matter to a final vote.

The action of the majority of the committee is scored in a minority report signed by Representatives Luce, of Massachusetts; MacGregor, of New York; Beedy, of Maine; and Hooper, of Michigan.

The majority points out that "whether the act was wise or unwise is not our province or that of the Treasury Department to decide. The act was passed in good faith and your committee deems it unwise to breach that faith by refusal to carry it out or to allow the Comptroller General or the Secretary of the Treasury to set aside a solemn act of Congress because it was expedient, in their judgment, to do so."

The majority also calls attention to the fact that "no purchases of domestic silver ever have been made under the act to replace the silver allocated or sold to the mint for subsidiary coinage. On the contrary, the Treasury Department undertook to set the allocations aside."

The minority sees in the bill a gift of nearly $7,000,000 by the taxpayers "to certain citizens who offer nothing whatever in return." It is contended that the whole question hinges on an interpretation of the Pittman Act, which is the function of the courts. It is not for Congress to say what is the meaning of a law already in existence, the minority says. To pass the bill, they assert, "will put into the vaults of the Treasury nearly 15,000,000 fine ounces of silver for which there is no use whatever. There this idle hoard will lie, doing nobody any good, serving no purpose, not supporting a dollar in circulation, earning no interest, aiding no industry, advancing no transaction of commerce—a dead mass of precious metal. All this because men differed as to the legal effect of certain bookkeeping entries in the Bureau of the Mint and because one side took its argument to Congress instead of to the courts."

Amended Potash Act

Senator Sheppard has proposed an amendment to the Potash Act which requires the payment of a 5 per cent royalty to the government on potash mined from lands within a radius of one mile from exploratory drill holes put down by the government. This is intended to supersede the present provision, which requires that the government be reimbursed for the cost of its work. The existing language does not make it clear that the government is to be reimbursed from sales of potash that may be recovered. For that reason land owners were unwilling to sign agreements.

Roebling Mineral Collection Gift to Smithsonian

One of the finest private collections of minerals in the world, that of the late Colonel Washington A. Roebling, builder of the Brooklyn Bridge, has been given by his son, John A. Roebling, to the Smithsonian Institution, Washington, D. C. The gift was accompanied by an endowment of $150,000 to insure maintenance of the collection.

This present makes the Smithsonian the possessor of the two greatest private mineral cabinets in this country, received within two months of each other. The first, containing 9,000 specimens, which was only surpassed by the Roebling collection of 16,000 specimens, recently came from Frederick A. Canfield, of New Jersey, and is endowed to the amount of $50,000.

The two gifts—added to the 50,000 mineral specimens already owned by the Smithsonian—put that institution ahead of any other in this country in mineralogical material and class it with the British and Vienna museums as the foremost in the world in this respect.

So complete a collection naturally contains many type specimens—specimens from which new species of minerals were described. This fact greatly enhances the scientific value of the collection, and the number of dubious minerals included will provide Smithsonian mineralogists an opportunity to reinvestigate them in an effort to determine what they actually are. The scientific value of the collection is said by experts to be inestimable.

Magnesite Duty Sought

The effort to improve the market for magnesite, an important natural product of Chewelah and Valley, Stevens County, Wash., is proceeding, according to word received at Spokane, Wash. Engineers on the staff of the United States Tariff Commission have concluded an investigation and placed the results in the hands of the commissioners. The large Eastern markets of this country are supplied with magnesite produced in foreign countries, as a result of cheap labor, low water freights, and interests in foreign mines said to be held by Americans. Foreign magnesite now pays a duty of $12.50 a ton on caustic and $6.25 on crude. Foreign producers are able to pay this and undersell the American producers. An increase in duty is being sought. Its increase, if sufficient, would enable the operators of Stevens County to add hundreds of men to their payrolls and would add much to the railroad freight handled.

More Potash Discovered in Crane County, Tex.

While drilling a test well for oil upon a tract of land leased from the State of Texas in Crane County, Stideham & Thresher encountered a bed of potash at a depth of 1,165 ft. The log of the well shows that the deposit has a thickness of 32 ft., with a high per cent of potash. The scene of this discovery is several miles from the locality where the Federal Government has designated potash experimental mining to be conducted.

It is reported that a number of potash-bearing lakes in Lynn and Terry counties, Tex., have been leased recently by a syndicate of Philadelphia men and that as soon as the deposits are thoroughly tested, steps will be taken to recover the potash.

Republic Camp Ships 4,000 Tons Monthly

The Republic camp, Ferry County, Wash., is more active than for many years and is shipping about 4,000 tons of ore a month to the smelter at Trail. The chief shippers are the Last Chance, controlled by Charles P. Robbins, of Spokane; and the Quilp, which has been taken over by eastern Canada interests. Each is shipping about 2,000 tons a month. The ore is a low-grade gold quartz greatly desired at the Trail smelter, which was advertising over the Northwest last year for just such a flux. One of the drawbacks to the camp, in the opinion of mining men, is the lack of electric power, and this it is hoped will be overcome. The line of the West Kootenay Power & Light Co. is said to be less than 20 miles distant, and the line of the Washington Water Power Co. is not far away.

Coeur d'Alene Companies Adopt Life Insurance Plan

Beginning with the new year, five mining companies operating in the Cœur d'Alene district, Idaho, adopted an employees' death benefit plan, which in effect is free life insurance for all employees, which applies in case of death not covered by the state workmen's compensation law. Should the death benefit under the state law be less than that provided by the companies, the difference will be made up under the plan just adopted. The insurance applies to all employees of the companies, from superintendent down the line, and the benefit will be the same without regard to position or salary.

The companies adopting this benefit plan are the Hecla Mining Co., Bunker Hill & Sullivan Mining & Concentrating Co., Sullivan Mining Co., Caledonia Mining Co. and the Sierra Nevada Consolidated Mining Co. The insurance is carried by the companies, and each employee taking advantage of it will receive a policy setting forth the benefit to which he is entitled and the dependents to whom it shall be paid. The amount of benefit depends upon length of continuous service of the employee. Dependents of an employee who has worked one year and less than two will receive $500, and from that the amount is graded up to employees who have worked ten years or over, who receive the maximum sum of $2,000. As a protection to dependents the following provision is made in the policy:

"The benefits herein provided for shall neither be assignable by the employee, nor subject to attachment or garnishment by his creditors, nor shall the benefits inure to his estate after death, nor to his beneficiaries or legatees by will, but shall be payable only to his dependents designated by him in the manner prescribed in these rules and regulations, or in case the employee shall leave no dependents, such sum as the company may determine, as hereinbefore provided, may be paid by the company to such person, firm, or corporation as the company may determine, to aid in the defraying of expenses of sickness or funeral; provided, however, that no right to such payment is given to the personal representative or creditors of such deceased employee."

New Brunswick Revising Mining Laws

Premier Baxter of New Brunswick announces that the mining laws of that province are under process of revision. They are being revised with the thought in view that mining should be made as easy as possible, so that prospecting for minerals will be encouraged. A study of the mining laws of Ontario has been made, and it is altogether likely that the more prominent features of these laws will be incorporated in those of New Brunswick, especially such laws as will encourage the prospector and discourage any who would secure and hold lands for a long period on speculation and without doing any real development work that would advance the industry.

George Graham Rice Enjoined from Sale of Colombia Emerald Stock

Supreme Court Justice Joseph Rosch has signed, on the application of the New York Attorney General, Albert Ottinger, an order restraining temporarily from fraudulent practices and misrepresentations in the sale of stocks and other securities, George Graham Rice (also known as Jacob S. Herzig), the Wall Street Iconoclast, Inc.; Frank J. Silva, Nash Rockwood, the Columbia Emerald Development Corporation, Edmund J. MacNamara and Frederick Lewisohn. The order was returnable on Jan. 8.

Rice, who has figured before in the sale and promotion of mining stocks, is made the central figure in the present proceeding. It is charged in the affidavit of Deputy Attorney General Keyes Winter that he sold the stock of the Colombia Emerald company, through misrepresentations in his *Wall Street Iconoclast*, a weekly paper.

Optimistic View of Ontario

IN A YEAR-END REVIEW of Ontario's mining industry, Charles McCrea, Provincial Minister of Mines, said: "Never perhaps in the history of Ontario has the promise of the mining industry in this province been greater or brighter than at the close of 1926. Never were the prospectors of Ontario, on whose activities rests the structure of the mining industry, more energetic, keen, or sanguine. Never were the hopes of the mining community at higher pitch. Never was it more apparent that the basic industry of mining is facing a period of expansion and prosperity. Ontario enters the new year, 1927, with high hope and optimism."

Subsidence at Michigan Mines Being Studied

The U. S. Bureau of Mines is carrying on important research work in the Michigan copper district through its representative, Dr. W. R. Crane. He is investigating the subject of mine subsidence or loss of ore due to caving. He has spent several weeks in the Champion mine of the Copper Range company and the Quincy mine, and will study conditions in the Calumet & Hecla properties. Later he will continue his investigations in the iron mines. The work will require about three years.

Lake Maron Company Starts Development

Installation of a mining plant is to be carried out at once on the property of the Lake Maron Mining Co. in Dasserat Township, Quebec. A good quartz vein was recently encountered on this property, but the fact that it is in low ground and covered by a heavy overburden makes it difficult to explore. This caused the decision to sink a shaft on the vein.

National Lead Interested in Montana

Representing the St. Louis Smelting & Refining Co., a subsidiary of the National Lead Co., Lester D. Frink, formerly superintendent of the North Butte Mining Co., is now making his headquarters at the Apex Hotel in Butte. On the theory that there will be a decided revival in lead mining, Mr. Frink is making a survey of lead-producing properties in Montana. In his opinion a number of Montana properties will enter the lead-producing field as a result of improvements in the reduction of lead-zinc ores.

Tungsten Production Company Increases Milling Capacity

The Tungsten Production Co., Boulder, Colo., has recently installed a new air compressor, extended its ore bins, and increased its concentrating capacity. The mill will be put on a full twenty-four hour day basis in a short time. One half of the earnings of the company go into new development work. On the Black King tunnel of the Tungsten company a new strike has been made which is 4 ft. wide and shows indications of greater width. It assays 10 per cent ferberite. The company employs ninety men. The property consists of ninety claims in three groups, with concentrating mill, power plant, and other equipment.

Airplane Service to Manitoba Mining Fields

A large Fokker monoplane is to be used to initiate a new aërial transportation service to the mining fields east of Lake Winnipeg in Manitoba and to the adjacent mining country in Ontario. This service is being put on by Western Canada Airways, Ltd., of which James A. Richardson, of the Winnipeg Grain Exchange, is president.

Low-Grade Ores of Vital Interest to Lake District

In explaining the necessity of research work in iron and copper to develop ways and means of utilizing low-grade ores, the Michigan College of Mines, at Houghton, emphasizes the time element as an important consideration. There is no fear of the distant future of the mining industry in Michigan nor of the next few years. The period with which the college and the industry are concerned is the "transition" period, and that, it is predicted, will come within the next quarter of a century. To prepare for that period it will be necessary to adjust methods to the mining and treating of a grade of material not now considered commercial. The successful industrial application of a feasible laboratory solution of difficulties will require several years.

It is estimated by geologists that of the lower-grade, or 35 per cent, iron ore, the Lake Superior district has about 70,000,000,000 tons. The problem of the low-grade ores must be solved, in the opinion of the college authorities, if the industry in Michigan is to be perpetuated.

Johannesburg Letter

By John Watson
Special Correspondent

Lydenburg Platinum Reports High-Grade Ore—Transvaal Platinum Closed

Johannesburg, Dec. 7—The following results of crushings for the month of November from fourteen leading Rand gold mines have recently been published. The mines are arranged in order of profits earned:

	Tons Crushed	Value or Revenue £	Costs per Ton s.	Costs per Ton d.	Estimated Profit £
Government Areas.....	200,000	389,856	16	1.2	230,156
New Modder....	130,000	301,534	18	11.4	178,374
Crown Mines...	206,000	297,367	20	2.1	89,504
Modder Deep...	44,200	99,662	15	3.0	65,924
Springs.....	69,600	130,352	18	9.8	64,860
Brakpan.....	84,000	134,405	18	9.1	55,611
New State Areas	72,000	131,641	21	7.9	54,218
Van Ryn Deep..	67,000	105,648	16	11.2	50,253
Modder B.....	66,000	109,889	18	5.1	49,084
Geduld.....	79,500	115,573	17	3.0	47,026
West Springs...	49,000	77,683	18	11.5	31,242
Randfontein....	190,000	209,249	19	1.2	30,140
Robinson Deep.	73,000	.....	18	9.4	25,601
City Deep.....	94,500	137,567	24	0.0	24,180

A fire broke out at the foundry of E. W. Tarry & Co., Johannesburg, on Nov. 29 and burned for over three hours, during which time damage to the value of more than £15,000 was done. Nearly one million wooden patterns for castings for machinery and parts, for the various mines, were destroyed. Everything was covered by insurance.

Lydenburg Platinum Areas, Ltd., recently reported that in prospecting on the Farm Elandsfontein it had located high platinoid values in the footwall of the Merensky reef. A two-ton bulk sample of this ore was sent to Johnson, Matthey & Co., London, which returned average values as follows: Gold, 2.76 dwt. per ton; palladium, 40.02; platinum, 49.68; rhodium, 1.96; iridium and osmium, 7.76 dwt. The total platinoids and gold equaled 102.18 dwt. per ton.

The annual meeting of Transvaal Platinum, Ltd., was held in the Corner House, Johannesburg, Dec. 3, W. H. A. Lawrence presiding. Development and extraction results have been so poor that the mine closed down recently. Early this year £30,000 was borrowed, to be repaid in March, 1927. The company's cash assets amount to £6,360. The report was criticized by Messrs. R. Paterson and Maclaren. Mr. Izod was re-elected a director.

T. W. Bathurst, Ltd., Reorganized

At a meeting of the shareholders of T. W. Bathurst, Ltd., held in Ottawa, Ontario, Jan. 3, a new company was formed to be known as the Bathurst Mines, Ltd., to take the place of the present company. The shareholders and directors authorized the ratification of a by-law with reference to the sale of their property to Thomas H. Rae, of Toronto, who represents J. Y. Murdock, H. W. Chadbourne, W. Bonbright, and others. The new company has a capital of two million shares of no par value.

Asbestos Corporation Files Suit Against Keasby Interests

Asbestos Corporation, Ltd., has filed a suit against Keasby & Mattison Co., Ambler, Pa., controlling the Bell Mines, Thetford, Que., with the object of forcing the terms of an agreement entered into at the time of the formation of the Asbestos merger. It was understood that when the merger was formed the Keasby interests, although not entering the merger, agreed to follow a certain policy designed to result in conditions that would allow the most profitable operations of the industry, and that the benefits to be derived as a result of following this policy would be shared by the Asbestos Corporation. The action was taken to allow the Asbestos Corporation to share in the benefits that have resulted.

Crown Reserve Sells Larder Lake Property

Crown Reserve has disposed of its property at Larder Lake, Ont., for $210,000, and a meeting of the shareholders was held recently to ratify the transaction. This action was taken owing to the refusal of a sufficient number of the shareholders to take up a stock offering, to provide further funds for the development of the property.

Zinc-Lead Deposit in Newfoundland Under Development

A massive sphalerite-galena orebody yielding 20 per cent zinc, 15 per cent lead, and some gold and silver, discovered in September at Red Indian Lake, Newfoundland, has been taken over by an American company and is under development, according to advices to the U. S. Department of Commerce from Lynn W. Meekins, trade commissioner at Ottawa. Mining operations in which about 400 men will be employed will be started during the coming spring, and production will commence in the fall of 1927.

Pavu Concessions Secures Claims at Kirkland Lake

The Pavu Concessions, Ltd., an English company which operates on the Gold Coast, West Africa, has entered the Kirkland Lake district of northern Ontario. It has secured a group of twelve claims in Bernhardt Township north of Tect Township, owned by P. J. Ashby and associates. The property is said to border an outcrop of granite, and showings already uncovered give assays of gold, silver, copper, and zinc. Camp buildings are now being erected and the company is preparing for an active campaign of exploration work next spring.

Sebakwe & District Mines Encounter 40-Ft. Lode

Continuing its tunnel to the north of B. C. Silver Mines territory, Stewart, B. C., Sebakwe & District Mines has penetrated a 40-ft. lode, averaging $3 in gold and silver per ton. Ten feet of ore on the footwall side shows better values; this now is being developed.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Area Development Delayed—Platinum Doubtful in Rouyn—Amulet Promising

The future of the Area property, in northwest Quebec, is still uncertain, as unexpected delays have been encountered. In starting to move the diamond drill to the new location the diamond-drill setter was unfortunately killed by a falling tree, which caused a delay of several days. When the drill was finally set up a large number of boulders were encountered in putting down the standpipe, and progress has been so slow that it will be necessary to move the drill to a new location.

To those who are not closely in touch with conditions in Ontario and Quebec, the Area situation may appear a remarkable one, but as a matter of fact the situation is unique in mining history. On the Area property prospecting had not revealed a single sign of ore. As a last resort electrical prospecting methods were used, and these indicated the presence of several large mineralized bodies. Before it was possible to prove or disprove the presence of ore the stock advanced 600 per cent and the wildest boom in the history of Canadian mining stocks set in. If the Area encounters high-grade copper ore this boom may continue for months, and a tremendous impetus will be given to development.

A good deal of publicity has recently been given to reports of high platinum assays from the Aconda property, in Rouyn. Assays of from $200 to $2,000 per ton have been given out by one of the directors, but under circumstances which look suspiciously like an attempt to make a market play, the news being given out within a couple of days of the time the stock was to be listed on the Mining Exchange in Toronto. The directors state that these assays were obtained last spring, but were so high that it was not considered advisable to make any mention of them. It is of course obvious that in the interval there has been plenty of time to check the matter up, and it is almost inconceivable that this would not be done, by people who really wanted to know the truth. So far as can be learned, however, no attempt has been made to do so, and the statement makes no reference to it.

There is no reason why platinum in small quantities should not be found in Rouyn, but it is understood that other companies have assayed for it without obtaining results of interest. It should be noted that the statement regarding high assays was made on the authority of only one director. The managers of the property are men of the highest reputation, and they, together with other directors, disclaim any knowledge of these results.

The report of the Amulet Mines for 1925, with a progress report up to Nov. 15, 1926, has just been issued. The delay in the issuance of the report was on account of important developments of which the company desired to in-

form the shareholders. The report refers to the several ore areas. On the No. 1 area all surface work has been completed and the body of commercial ore which has been indicated will be diamond drilled. A section 36 ft. long gave an average assay of $9. On the No. 2 ore area no further work is contemplated until the railway is in operation. Three distinct orebodies have been indicated, on the larger of which an estimate has been made of 160,448 tons of ore having a value of $3,392,000.

Indications of other orebodies have also been given by electrical prospecting, but nothing definite regarding them is known as yet. A railway spur will be built to the "A" group in the summer of 1927 and an electric transmission line is now being constructed.

Towagamac Sells Treasury Stock

Directors of the Towagamac property, in Rouyn, have decided to offer the balance of the treasury stock, amounting to 149,990 shares, to shareholders of record Jan. 15, 1927, pro rata to their holdings as of that date, at a price of $3.50 a share. This action has been taken to permit the company to take advantage of the opportunities that are occurring in the rapid development of the Quebec field. With the issue of this stock the company will have approximately $750,000 cash on hand.

Teck-Hughes Encounters Better Ore

The Teck-Hughes mine, of Kirkland Lake, has declared a dividend of 5 per cent, payable Feb. 1. Within the last few days an important discovery has been made in sinking the new shaft. At the 15th level, which has a depth of 1,750 ft., ore was encountered which showed a width of 7½ ft., averaging $140 to the ton. It is expected that the new mill will be in operation in February, and though no estimate has been published it is believed that mill heads will run approximately $20.

At the Kirkland Lake Gold mine an entirely new oreshoot has been found west of the shaft on the 2,350-ft. level. The first 60 ft. of ore overaged $7 to $8 a ton, and since then an additional 50 ft. has been proven, with an average grade of $25 a ton over widths of 5 to 6 ft. Production during December amounted to a total of $52,000, which constitutes a record for the property. The mill averaged 150 tons a day and the grade was about $12 a ton.

At the Tonopah Canadian mine, in Gowganda, a mill run of 1,500 tons of ore from the Morrison property has been completed. The average value of this ore was 26 oz. to the ton, and the material represents a length of 200 ft. along the vein from the 300 and 375 levels. The distribution of silver in the Morrison property is erratic, as only a small quantity is of high grade and the silver is found as mill rock over a depth of 4 to 5 ft. Ordinary sampling methods cannot be relied upon to give an accurate estimate, so it was decided to make a large-scale sampling test by running this tonnage through the mill. The mill is treating 60 to 65 tons a day, and a substantial production is being maintained.

Mexico City Letter

By W. L. Vail
Special Correspondent

Government Optimistic Regarding Mining Situation—Silver Taxes Reduced

Mexico City, Jan. 3—Mexican government officials continue to take an optimistic view of the mining situation, on the threshhold of the new year, which view is not generally accepted by many of the larger mining interests. Just how far the authorities are prepared to go toward making effective the new laws, in view of the fact that many mining companies and probably hundreds of individual mine owners have failed to comply with all the demands laid down by the government, is still a matter of speculation.

The principal mining camps of the country have met conditions resulting from the heavy depreciation in the price of silver, principally by cutting out all unimportant work, and in some instances by a readjustment in wages. Though copper continues low, the recent increase in the federal tax must embarrass operations. Lead and zinc production continue good on account of satisfactory prices.

According to figures just given out at the mining headquarters the total mineral production for the ten months of 1926 ended Oct. 1 shows a 15 per cent increase over a corresponding period of 1925. During October, 1926, gold production was 2,187 kilos, against 2,297 in October of 1925. Silver production, on the contrary, was slightly in excess of the output of 1925, 298,977 kilos in October, 1926, against 261,823 in October, 1925.

As an argument in favor of better times for the industry, the Secretary of Commerce, Labor, and Industry cites the fact that two refineries have just begun operation and three more will be ready to operate within a short time. Other installations cited by the Secretary are: The Peñoles company, which has just signed a contract with the Lepanto Mining Co., and is establishing a concentrating plant at Naica, State of Chihuahua, for treatment of Lepanto ores. Work has begun at Mapimí on a flotation plant of 250 tons' capacity under the direction of the Peñoles company. A 100-ton smelter is now under construction by the Copalitos Mining Co., Sinaloa, and three other units of the same capacity will be undertaken during the present year. The San Nicolas Milling & Mining Co., of La Parilla, Durango, has completed a smelter at a cost of half a million pesos, for handling lead and zinc ores. The United Mines Co., working at Melladido, Guanajuato, has completed a new flotation plant and expects to be running regularly before the end of this month.

Sale of the Porvenir, La Dolorosa, and La Trinidad mines, in the Sierra de las Damas, State of Chihuahua, to the Real del Monte Co., of Pachuca, for 160,000 pesos is confirmed.

The state government of Oaxaca has reduced the land tax on mines 50 per cent; also 50 per cent of the taxes due to the state treasury on production, and remits back taxes to date, provided the present year's obligations are promptly met. This action was taken to assist the mining operations in the state, many mines having closed because of the low price of silver and inability to meet mining taxes.

Congress Reduces Silver Tax

Congress has finally passed an emergency measure intended to partly offset the bad effects of the tragic fall in silver. Under the provisions of this measure, when silver is quoted from 57 to 60c. per ounce in New York, the federal taxation will be 5 per cent; over 54c. and under 57c. per ounce, the tax will be 4.25 per cent; from 51 to 54c. per ounce, the tax is 3 per cent; 48 to 51c., 1.75 per cent; 45 to 48c., 1 per cent and under 45c. per ounce the tax will be .75 per cent.

With regard to low-grade ores carrying exclusively silver and gold, the following rates are established: From 8 to 9 peso ore, a reduction of 40 per cent of the present tax is allowed; 9 to 10 pesos, 30 per cent; 10 to 12 peso ore, 20 per cent. The government is also making a study of railway tariffs for the purpose, if practicable, of making certain reductions on low-grade ores which cannot stand the present rates of transportation.

The Department of Commerce, Industry, and Labor continues to publish statistics and arguments intended to minimize the effects of the depression in silver prices. A recent statement says that prior to 1885, in which year the first metallurgical plant was established in Mexico for the treatment of copper ores, and later for the treatment of zinc and lead ores, the metal output of the country was almost exclusively gold and silver. The average annual output of silver in the fifteen years immediately prior to 1885 was 669.898 kilos and of gold 1,570 kilos. Silver then represented, in values, 97.03 per cent of the annual mineral output of the country. In 1920, though silver continued to lead all other metals in production, the actual value only represented 42.08 per cent of the values of all mineral productions. The mint in the City of Mexico has stopped the coinage of silver.

Dos Estrellas Settles Labor Troubles

According to the best information obtainable, Dos Estrellas has settled its labor troubles, at least for the present, and the threatened suspension has been averted. It is understood that an average reduction in the pavrolls of about 18 per cent was accepted. Dos Estrellas has been running about 200 tons daily at a cost approximately of 7 pesos per ton.

Albert Bellanger, consulting engineer for the Rothschilds (Paris) interests in Mexico, has returned to Europe after several weeks spent on properties of the syndicate, principally at the Boleo mines, in Lower California. Mr. Bellanger reports conditions good, except for the recent copper tax. Labor troubles have been adjusted. The sum of 48,000,000 francs was recently subscribed in Paris for the purpose of increasing operations at Boleo.

London Letter

By W. A. Doman

Special Correspondent

Burma Completes Satisfactory Year—Bawdwin Increases Operations

London, Dec. 28—Despite all the drawbacks experienced by the Burma Corporation during the twelve months ended June 30 last, the report and accounts for that period are entirely satisfactory. The working profit is £1,361,357, which, with miscellaneeous income, makes the gross working profit £1,449,450, compared with £1,413,341 in the preceding twelve months. The total dividends amount to 13 annas per share, free of tax, an increase of 1 anna over the 1925 period. Shareholders in this corporation have had considerable difficulty in reclaiming income tax on their dividends, and though the London office has assisted them in every way possible, it has not been able to achieve very much, for I believe that only about 10 per cent of shareholders have applied for a refund of tax. Now the position will be even worse, for all income-tax repayment claims must be made through the Indian office, as the Indian Government has taken the matter in hand. This is unfortunate, as the Burma Corporation shares constitute a fine investment, but are not likely to increase in popularity with the difficulties thrown in the way of reclaiming income tax—and it is no light matter, as I have been informed in authoritative quarters.

At the Bawdwin Mines operations have continued on an increased scale, and the work of salving the area that had been under fire was so satisfactory that during the last quarter of the financial year 25 per cent of the tonnage mined was derived from this area.

The total tonnage mined during the twelve months was 356,222, in comparison with 289,006 tons in the previous period. Thirty-five per cent of this tonnage was mined in the 540 level, but though the total extracted showed an increase of 23.3 per cent on the year, the grade, owing to the fire, was silghtly lower. In spite of lower silver and lead values there was an increase of 16.7 per cent in the silver content and of 15 per cent in the lead content, compared with the preceding period. That all of the ore extracted was not replaced was due to the fire, ore reserves showing a decrease of 229.502 tons at 4,140,571 tons. The metallic contents are given as 22.3 oz. silver, 25 2 per cent lead, and 16.6 per cent zinc, all of these values showing slight increases on the figures of the previous year. The general manager points out that 6 per cent more tonnage was treated in the twelve months under review, and that the lead concentrate sent to the smelter contained more lead and less zinc per ton than in any previous year. Recovery of zinc as a commercial product increased from 22.4 per cent in 1924-25 to 36 per cent for 1925-26, being as high as 50 per cent for the final quarter of the year. Owing to the death of F. A. Govett, Sir Robert S. Horne has been appointed chairman of the company.

The slowing down of the motor-car industry in the United States has been watched with much interest on this side, as, if the motor-car industry is unfavorably affected, less tin is required. Reports have been received of a reduction of employment, and this, together with larger shipments of metal direct from the East, and the expectation of an increase in the total visible supplies at the end of the year, has caused a setback in the price of tin to £301 per ton. Though this condition of affairs is regarded as transitory, it certainly came as shock to bulls of tin who had been looking for higher prices and, in fact, who had talked about higher prices ruling for some years.

Brazilian Exports of Manganese to U. S. Increase

Practically all of the manganese ore exported from Brazil is shipped from Rio de Janeiro, whose shipments to the United States during the first ten months of last year amounted to 253,640 long tons, valued at $3,002,-499, compared with 200,612 tons, valued at $2,465,297, in the January-October period of 1925, states a report by the U. S. Department of Commerce. These shipments are largely dependent upon the available railway facilities from the mines to Rio de Janeiro.

Soviet Manganese Concession

It is reported from Moscow that W. A. Harriman has reached an agreement with the Soviet government for a modification of the Georgian manganese concession. Harriman wished to drop the clause providing for building of a railway at Tchiatouri, because he found the cost three times the amount originally understood. He has proposed to substitute a narrow-gage line instead.

Harriman is said to have proposed to form a financing company for Russo-American trade, with New York bankers participating with $5,000,000 capital. Mr. Harriman, who is now visiting Georgian manganese fields, will return to New York about the middle of January. He stated that the Georgian output is now 180 carloads daily.

Rowack Gruenfeld, with the backing of the Deutsche Bank, is reported to have secured an extension of the Nikopol, Ukraine, manganese concession for another year after 1927, making it doubtful if W. A. Harriman will be successful in suppressing this competition with his Georgian concession. It is reported that the German competitor is making Soviets a preliminary payment of 3,000,000 rubles. Final details will not be concluded until the end of January.

Spain Removes Export Duty on Iron Ore

The Government of Spain has removed the export duty on iron ores in order to facilitate the operation of the iron mines. Further revision of the duties on exportation of other ores and metals is under consideration.

Bombay Letter

By S. G. Warty

Special Correspondent

Steady Decline in Petroleum—Iron Production Increases—Manganese Exports Drop

Bombay, Dec. 11—Statistics of petroleum production in India during recent years prove that it is becoming more and more difficult to maintain the output at the high level reached in 1919 and 1921, when production reached 305,000,000 gal. In 1924, the production was 294,000,000 gal. and in 1925, 289,000,000 gal. Dr. Pascoe, director of the Geological Survey of India, says that the inevitable decline has set in and, with possible interruptions, is likely to continue slowly and steadily during the present generation unless a new field of importance is discovered. The chances of the latter recede year by year as exhaustive geological research continues to prove fruitless. Dr. Pascoe advises a conservative policy rather than one of intensive development, especially in view of the national importance of this mineral asset.

The quantity of iron ore produced in India has been steadily increasing. In 1923 there was an increase of 29 per cent over the record for the previous year; in 1924 an increase of 75 per cent, and in 1925 an increase of 7 per cent, the production in the last year amounting to 1,544,000 tons. The output of refined products at the Tata works at Jamshedpur showed substantial increases in pig iron and steel, including rails. The former rose from 540.140 tons in 1924 to 563.160 tons in 1925 and the latter from 218,500 tons in 1924 to 310,000 tons in 1925. Between the same periods there was a decrease in production of ferromanganese, from 9,000 tons to 6,500 tons. The production of the Bengal Iron & Steel Co. and the Indian Iron & Steel Co., now amalgamated, together amounted to 300,000 tons of pig iron, 6,000 tons of iron castings, and 29,000 tons of sleepers and pipes. The Mysore Iron Works produced 16,700 tons of pig iron. Total pig iron production amounted to 880,000 tons, of which 382,000 tons was exported.

Manganese Production Increases

The total output of manganese ore in 1925 amounted to 840,000 tons, an increase of about 37,000 tons over 1924, but exports showed a decline during the period from 658,000 tons to 604,000 tons.

The decline in exports is due to the steadily increasing consumption of manganese ore at the works of the three principal Indian iron and steel companies, not only for the use in the steel furnaces at the Tata works and the manufacture of ferromanganese, but also for addition to the blast-furnace charge in the manufacture of pig iron.

Exports of Indian coal are steadily increasing, which shows that the industry is slowly but steadily reviving from the adverse conditions that had overtaken it.

Recent Technical Publications

Reviews, Abstracts, and References

For Both the Lay and Scientific Reader

Our Mobile Earth. By Reginald A. Daly. Charles Scribners' Sons, New York. Price, $5.

This is an attractive volume in which a vast amount of material is simply and lucidly set forth. The large print, ample spaces, and numerous illustrations have done their important part in making reading a pleasure, and the author has plainly exerted himself to the utmost to make the language simple and his meaning clear. The prevalent pedantry and love of the terminology of the scientist is here openly and studiously abandoned—no unusual word is used where a simpler one could do. The text is also sprinkled with patient explanations and asides which give an air of leisure to the volume,—a spirit quite in keeping with the subject, for though our earth is undoubtedly mobile, as the title of the book states, yet this mobility is very ancient, and it will undoubtedly endure for myriads of years.

The casual reader either of this review or of the book might deem it a semi-popular contribution for the public. There are no footnotes, no citing of literature (except in an appendix), no pseudo-conscientious references to what everybody else has thought and written on the subject since geological literature began. It is a plain story, told as simply as the situation allows. It presents the views of the author as to all the complicated phenomena of earth movement in all its phases; it puts forth the views of Professor R. A. Daly—take 'em or leave 'em. Students will probably take some, and leave others—at least in suspense—according to their views. The reviewer is no exception. But as an example of a highly scientific work which combines near the maximum amount of literary value, the book represents a pattern which might well be widely followed.

As to the scope, the chapter heads give an indication. Chapters I and II are on Earthquakes; and to these chapters the general as well as the scientific reader is recommended. Chapter III treats of the Earth's Interior; Chapter IV is on Volcanic Action; Chapter V on Changes of Sea Level and Distortion of the Earth; Chapter VI on Mountain Ranges and Chapter VII discusses their origin; while Chapter VIII treats of the evolution of the Face of the Earth.

If and where the author ventures partly or whole-heartedly into the realms of speculation, he warns the reader that such is the case. He has collected and presented a vast array of facts, a veritable mine of information, regardless of deductions. Some of his views are novel—that is, stated in this book for the first time. Space does not permit individual criticism of the conclusions involved; indeed, one would hardly attempt it before reading the book a second and a third time. All in all, a very marked contribution to science and literature and a fitting succession to the illuminating work by the same author on Igneous Rocks and Their Origin. J. E. SPURR.

Economic Geology—The September-October issue of *Economic Geology* (Lancaster, Pa.; price 75c.) contains the following articles: "Successive Banding Around Rock Fragments in Veins," pp. 19, by J. E. Spurr; "Oil and Gas Accumulation, Clinton Sand, Ohio," pp. 23, by W. L. Russell; "Significance of Hematite in Certain Ore Deposits," pp. 19, by G. Gilbert; "Sedimentary Analysis of Limestones of the Chester Series," pp. 9, by J. E. Lamar; and "Ore Deposition at Premier Mine, B. C.," pp. 20, by W. D. Burton.

The November number of the same magazine contains: "The Soudan Formation and the Origin of the Vermilion Iron Ores," pp. 17, by J. W. Gruner; "Brief History of the Oil Position in Australasia," pp. 4, by A. E. Broué; "The Preparation of Polished Sections of Ores," pp. 18, by M. N. Short; "Natural Gas Beds, Golden Eagle Field, Wyoming," pp. 31, by Edwin Binney, Jr., and "Minerals of the Intermediate Zone, Butte, Mont.," pp. 14, by W. M. Agar.

The December issue of *Economic Geology* contains the following papers: "Revision of Coal Estimates for West Shansi, China," pp. 15, by M. L. Fuller and F. G. Clapp; "Geology of the Jerome District, Arizona," pp. 18, by J. L. Fearing, Jr.; "A Salt Dome in Northern Siberia," pp. 9, by I. P. Tolmachoff; "Tourmaline-Bearing Cinnabar Veins, Mazatzal Mts., Arizona," pp. 11, by Carl Lausen; and "Bauxite in Alabama," pp. 12, by W. B. Jones.

Alaskan Surveys—U. S. Geological Survey Bulletin 783-E, pp. 16, by Philip S. Smith, J. B. Mertie, Jr., and W. T. Foran, is a "Summary of Recent Surveys in Northern Alaska." The country covered is part of the 35,000-mile tract set aside by President Harding as a naval petroleum reserve; that is, provided there is any oil there. Two seepages near Camp Simpson are the only indications herein reported, and they are not enough to make any scandal likely.

Geophysical Prospecting—Dr. C. A. Heiland discusses "Geophysical Methods in Mining" in an 8-page article in *The Mining Congress Journal* for November (Washington, D. C.; price 30c.). He deals with the measurement of the gravitational, magnetic, radioactive, geothermal, and spontaneous electrical effects produced by ore deposits.

Milling at Midvale—"Milling Practice at Midvale, Utah," was discussed at some length by C. A. Lemke in an article under this title in the Oct. 30 issue of *The Arizona Mining Journal* (Phoenix, Ariz.; price 20c.). A selective separation of lead-zinc-iron sulphides by the flotation process is employed.

Colemanite in California—L. F. Noble contributes an 11-page article on "A Colemanite Deposit Near Shoshone, Calif., With a Sketch of the Geology of a Part of Amargosa Valley," to Bulletin 785 of the U. S. Geological Survey, this being known as Part D. The orebody is being worked by the Pacific Coast Borax Co. and consists of colemanite mixed with clay, shale and some ulexite. Copies of the bulletin may be obtained on request to the Survey, Washington, D. C.

Industrial Diamonds—The Selma Mercantile Corporation, 15 Moore St., New York City, representing Anton Smit & Co., of Antwerp, has published a brief but informative pamphlet entitled "Diamonds for Industrial Purposes." Part 1 describes carbons, ballas, borts, splints, and diamond points. Part 2 discusses the principal uses of diamonds in rock drilling and boring, trueing grinding wheels, diamond dies, and diamond saws. Copies of this 20-page pamphlet may be obtained on request.

Mining Accidents—"Metal-Mine Accidents in the United States: 1924," by W. W. Adams, U. S. Bureau of Mines Bulletin 264, was recently published. The fatality rate during the year was increased by the loss of 41 lives in the Milford mine flood, in Minnesota, on Feb. 5, 1924, but the general trend has been downward since statistics became available in 1911. Copies of the bulletin are available for 15c each from the Superintendent of Documents, Washington, D. C.

Canadian Mines — "The Financial Post Survey of Mines, 1926," is perhaps the best guide and directory of Canadian mining and mining companies that is obtainable. Brief histories and future possibilities of the various mining districts of the Dominion are given, and each individual property is given space in the manner made familiar in Weed's "Handbook." Numerous charts, tables, photographs — and advertisements—are incorporated in the 300-odd pages that make up the book. An excellent job has been done. To those who might think at first glance that the book has no index, it may be said that an excellent one begins on page 7 in the front of the book, instead of in the usual position at the end. The book is published by the Maclean Publishing Co., Ltd., Toronto. Whether or not a charge is made for it is not stated.

Electrical Prospecting—"Results Obtained by the Schlumberger Method of Electrical Prospecting" in Japanese mines are discussed in a 26-page article illustrated with many colored maps and charts, in Vol. 4, No. 3, of the *Memoirs* of the College of Engineering, Kyoto Imperial University, Kyoto, Japan. The author is Yoshizo Fujita.

In the November *Bulletin* of the Canadian Institute of Mining and Metallurgy (Drummond Building, Montreal; price $1) also appears 27 pages of matter relating to methods of electrical prospecting, including brief papers on Swedish Methods, by Hans Lundberg, on the Elbof Method, by E. E. Mueser, and on the Schlumberger Method, by Sherwin F. Kelly.

People You Should Know About

F. S. Gourley, sales manager for the Calumet & Hecla Consolidated Copper Co., has resigned, and has accepted a position in the sales department of Guggenheim Bros.

C. T. Eastman, president of the American Development Corporation, has been in Reno, Nev., from his San Francisco headquarters.

C. T. Van Winkle, consulting engineer of Salt Lake City, has returned from a professional visit to the Black Hills district, South Dakota.

Fred L. Cole, manager for the T. F. Cole interests in Nevada, has returned to his home in Tonopah from a visit in Southern California.

Alex Wise, president and manager of the Flowery Mines Co. near Virginia City, Nev., has returned to Virginia City from San Francisco.

L. D. Gordon, president and manager for the San Rafael Development Co., operating at Quartz Mountain, Nev., is in San Francisco on business.

A. G. Burritt, Salt Lake geologist and oil operator, returned to Salt Lake for the holidays from the Piney-La Barge field, near Kemmerer, Wyo.

J. D. Coplen, of Los Angeles, former owner of what is now the Inspiration copper mine, which he sold in 1908, was a recent visitor at Tucson, Ariz.

John C. Callinan, who with associates recently purchased the Baker-Paton copper property in northern Manitoba, has returned from the property to Toronto.

William H. Hax, of Scranton, Pa., who is at the head of the Basin Montana Tunnel Co., is in Butte attending to details looking toward the starting of operations.

R. N. Diggles, of Gazelle, Calif., has accepted a position as metallurgist and mill superintendent with the Buckingham Mina Consolidated Mines Co., at Battle Mountain, Nev.

R. C. Canby, consulting metallurgist of Wallingford, Conn., returned from Buenos Aires on Dec. 29, and has gone south to report upon a proposed improvement in the cyanide process.

W. H. Emmons, geologist, has been engaged by the Mining Corporation of Canada to make an examination of the corporation's holdings in Montbray Township, in the Rouyn area of the Province of Quebec.

The Marquis of Anglesea, who owns petroleum and gas rights covering 4,880 acres 22 miles south of Calgary, Alberta, on which gas has been struck at shallow depths, is arranging to drill for oil in the spring.

S. Power Warren, of the Colorado School of Mines, has just returned from a trip to Canada, where he was called to the Tetreault mine, at Notre Dame des Anges, Que., for a conference with the men in charge for the British Metal Corporation.

Dr. W. L. Goodwin has been conducting a series of prospectors' classes under the auspices of the Ontario Department of Mines at Sault Ste. Marie, and states that results showed a marked improvement compared with the classes of previous years.

T. L. Joseph, a University of Utah graduate, and now superintendent of the North Central Station of the U. S. Bureau of Mines at the University of Minnesota, has been awarded the $200 cash award from a fund donated by Mrs. Margaret Hilles Johnson, in memory of her husband, J. E. Johnson, Jr., for recognition of service to the metallurgy of iron and steel. Mr. Joseph, who was awarded the prize by the directors of the A.I.M.E. for contributions to blast-furnace operations, took the degree of M.A. at the University of Utah in 1917. He was formerly chemist for the International Smelting Co. at Tooele. This position he resigned to join the army during the war. After being discharged from the service in 1919 he accepted a position as metallurgical chemist with the Bureau of Mines and was assigned to the north central station.

T. L. Joseph

Lewis Merritt, Duluth mining man, recently spent a week visiting Utah mines adjacent to Salt Lake. Mr. Merritt is heavily interested in the Moscow Silver Mines Co. enterprise in the Star district near Milford.

J. O. Elton, manager of the International Smelting Co., recently made a trip to Butte, Mont., to attend the funeral of Harry S. Ware, assistant general superintendent of the Anaconda Copper Mining Co. reduction works.

Leo Hannebach, for many years associated with the metallurgical department of the American Smelting & Refining Co., has been transferred from San Francisco headquarters of the company to the ore-purchasing department at Salt Lake.

Charles A. Burdick, mining and metallurgical engineer and formerly valuation engineer, Bureau of Internal Revenue, Income Tax Unit, has resigned from government service and opened offices in New York and Washington, D. C., for private practice.

B. B. Nieding, of Kennecott, Alaska, general manager of the Kennecott and associated mining companies, recently spent several days in the Coeur d'Alene mining district, Idaho, for the purpose of inspecting the flotation process as practiced in the various mills of the district.

Dr. H. Pirow has been appointed Government Mining Engineer to the Union of South Africa. He was born in the Graaf-Reinet district of the Cape and was educated in South Africa and Europe. In 1923 he obtained the first doctor of science degree awarded by the Witwatersrand University to a mining student.

H. W. C. Prommel, consulting geologist, who made the first detail maps of the Colorado River structures in San Juan County, Utah, now attracting considerable attention, has changed his headquarters from Wichita Falls, Tex., to Denver, where he will engage in private practice. Mr. Prommel made a reconnoissance of the territory adjacent to Las Vegas, Nev., before the holidays.

Premier Taschereau of the Province of Quebec has returned from a journey covering 1,500 miles to the Quebec and Ontario gold fields, in which he was accompanied by a large party comprising S. J. Hungerford, vice-president of the Canadian National Railway; J. Y. Murdock, president of the Noranda Mines; Walter Mitchell; Senator Wilson, and others. The Premier expressed himself as astonished at the progress made in the Rouyn field and satisfied with the railway operating between Rouyn and Taschereau, the results of which had justified the government in what it had done to meet the requirements of the field.

Obituary

Carl Akeley, inventor of the cement gun and a noted American big-game hunter, died recently at Kible, Uganda. He was sixty-two years old.

Samuel B. Harper, secretary of the American Silver Co., died on Tuesday, Dec. 21, 1926, at Bristol, Conn. Mr. Harper was in his seventy-sixth year.

Myron A. Folsom, attorney and mining man, died in San Francisco on Jan. 1. Mr. Folsom graduated from Stanford University in 1895. He became associated with the Crocker and D. O. Mills interests in the Bunker Hill & Sullivan company and was attorney for that company for twenty years. Mr. Folsom was fifty-four years old. He leaves a widow and four children.

Harry S. Ware, assistant general superintendent of the Washoe Reduction Works, at Anaconda, Mont., died on Dec. 6. Mr. Ware was born in Memphis, Mo., in 1879. He started in the laboratory at Anaconda in 1904, becoming subsequently chief chemist, superintendent of blast and briquette plants, assistant superintendent of the smelter, and about 1916 was appointed to the position which he filled until his death. Mr. Ware joined the American Institute of Mining Engineers in 1913 and was one of its most active workers. He leaves a wife and three children.

New Machinery and Inventions

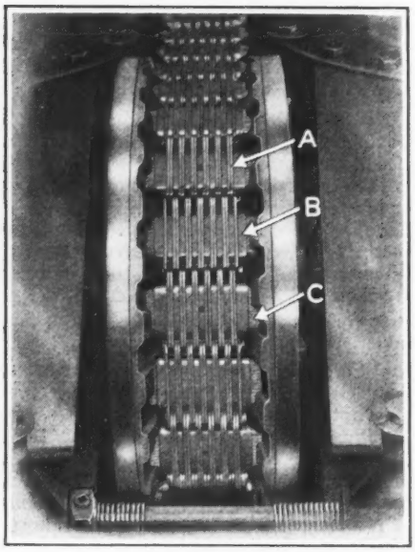


Fig. 1—A positive-drive change gear

Although the speed is variable between the driving and the driven units the action is positive, on account of the special construction of the chain.

Though Variable in Speed This Drive Is Positive

A type of positive-drive change gear, known as the "P.I.V." (positive infinitely variable), in which it is possible to alter the speed ratio between a driving and a driven shaft to an indefinite degree within the range of the gear, has been developed by the P.I.V. Gear Syndicate, Ltd., 7 Princes Street, Westminster, London, S.W.1.

The essential principle of the gear consists in the use of a driving chain of special construction which runs, if necessary, at short centers between two split pulleys of the opposed conical disk type, one set on each shaft, sloping down at an angle of 30 deg. to the shaft on the inner faces. These faces contain alternate ribs and grooves radiating from the center, which are broader at the periphery and narrower at the hub, while also the two halves are staggered in the sense that a rib is always opposite a groove. The chain is engaged at the edges by these ribs, which act as teeth, so that the drive is positive.

The chain consists of composite links formed of plates *A* (Fig. 1) with a longitudinal slot containing a sleeve or casing *B* open at each side, inside of which is a pack of small thin steel plates or slats *C*, which are, however, loose in the sense that each can move in a direction at right angles to the travel of the chain. These slats project in turn from each side into the grooves between the ribs, and in running, as a link enters the V of the pulleys, the ribs or teeth of one side of the pulley push the requisite number of slats across into the space on the opposite pulley face. Also to insure continous and easy running the driving edges of the wheel teeth are not at right angles to the wheel faces, but are inclined somewhat so that there is no possibility of half a slat being necessary to fill the space completely.

To alter the speed of the driven shaft, the halves of each of the split pulleys are made to slide along the shaft by turning the handle *D*, Fig. 2. This operation brings the faces of one pulley closer together and at the same time pushes the faces of the other pulley farther apart, thus changing the relative speed of the two shafts.

The smallest standard gear is rated up to 5 hp. and has a speed ratio of 6 to 1, the whole being contained in a closed box 20½x13½x10 in. The next larger size is rated up to 15 hp. with the same ratio and an over-all size of 29x13½x14½ in.

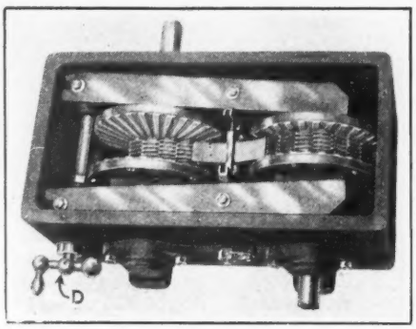


Fig. 2—Speed changes easily made

When desired the speed of the driven unit in changed by turning handle *D*. The whole arrangement can be obtained in a closed box flooded with oil, or operated as an open drive at long centers.

Oil Pressure Operated Remote Control Valve

A remote control made by the General Electric Co., Schenectady, N. Y., operates a valve with oil pressure, electrically controlled. The valve is opened and closed by oil that is pumped into the cylinder by a small motor-driven rotary pump. The control equipment consists of a reversing switch, two interlocked pressure switches and an "open-closed-stop" push-button station. The energizing coil on the reversing switch is connected through the contacts on the pressure switch so that, when one of these devices is opened, the other is closed. The coil is also connected to the push-button stations.

In order to open the valve, the "open" button is depressed. Oil is pumped from the top of the valve cylinder into the bottom, thus forcing up the piston and opening the valve. When the valve is open it builds up the pressure on the pressure switch, opening the energizing circuit and the reversing switch and, because of the interlocking features on the devices, it closes the pressure switch contacts on the closing side of the valve.

To close the valve the "closed" button is pressed, the oil is pumped from the bottom of the valve cylinder to the top and the piston is forced down. As the gate seats pressure is built up. This opens the pressure switch and thus stops the motor. The pressure switch is placed in position for operating when it is desired to open the valve. Incandescent lamps are so arranged that they indicate at all times the position of the valve, whether open, operating or closed.

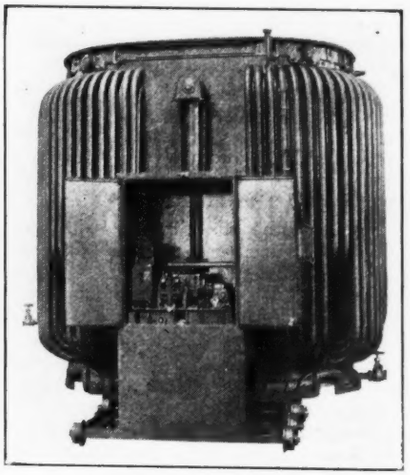
Controlling Load Ratio in Belgium

By use of transformers equipped with load ratio control, a Belgian copper refinery will control the current used in its electrolytic processes by varying the voltage applied to a rotary converter, and without interrupting the circuit. By this method the Oolen Refinery of the Société Générale Metallurgique de Hoboken will be able to exercise remote control of its processes by means of two push buttons on the control panel.

The installation will consist of two 915/1840-kw., 750-r.p.m. synchronous converters and two oil-cooled transformers rated 2,055 kva., together with necessary switchgear. This equipment will be installed in a new refinery in Hoboken, Belgium, where copper from the Belgian Congo will be brought and refined. All the electrical equipment will be of General Electric manufacture, and that company is now also building three 4,000-kw. motor generators for a large leaching plant in the Belgian Congo, a subsidiary of the Société Générale Metallurgique de Hoboken.

The Belgian transformers will take their power from a 3-phase, 6,600-volt, 50-cycle circuit and will deliver 5,270 amps. to the rotary converters at a pressure which can be varied from 66 to 130 volts in nine steps. Finer adjustments in the direct current voltage will be obtained by field control.

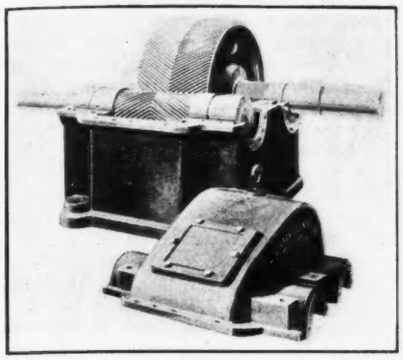
The motor drive of the load ratio control will accomplish one complete tap change in about ten seconds. It will be possible to operate the tap-changing mechanism by hand, with the motor disconnected. On the switchboard there will be an indicating instrument to show the attendant on which tap the transformer is operating.



Exterior view of transformer. Housing of tap-changing mechanism is open

Longer Life for Speed Reducer Through Smooth Operation

The manufacture of speed reducers using herringbone gears has been announced by the D. O. James Mfg. Co., 1122 W. Monroe St., Chicago, Ill. These units are being built in reduction ratios



Smoothly running herringbone gears

of from 2 to 1, to 150 to 1, and in capacities of from 2 hp. to 200 hp. The company states that these reducers are being built to fill a demand for heavy, rugged and durable types, especially under conditions where heavy equipment is driven.

On account of using herringbone gears the builder claims that all backlash and play are practically eliminated, which gives longer life because there is less resulting shock vibration and friction. The design has provided for overlapping action which gives smoothness and is also noiseless.

Spring Motor Quick Trip Made for Recording Meters

About a year ago the Esterline-Angus Co., Indianapolis, Ind., announced an electric-motor-driven quick-trip graphic instrument for making records at exceedingly high chart speeds. In this instrument an electric motor, running continuously, is brought into engagement with the chart drive by an electro-magnet whenever an electrical disturbance occurs. As a result of the experience with these instruments a demand sprung up for a quick-trip instrument which does not have the continuously running motor. There are many places where a separate circuit for the operation of the motor is not available and obviously such a machine could not well be operated from the circuit whose disturbances it is intended to record.

To meet this demand the company has developed a spring motor capable of driving the chart for several minutes at a speed of ¾, 1½, or 3 in. per second. These instruments are in every way standard, except for the attachment which makes the high chart speeds possible. When conditions are normal the clock in the instrument case drives the chart at slow speed. When a disturbance occurs the closing relay operates an electro-magnet in the motor case and in less than $\frac{1}{25}$ second the spring motor brings the chart to either ¾, 1½ or 3 in. per second. As soon as the disturbance ends the relay opens the circuit of the electro-magnet, the spring motor continues to drive the chart at high speed until it is brought to the proper time, when the motor is disconnected and the clock resumes driving the chart at slow speed until the next disturbance occurs. The device for resetting the chart to the proper time after a disturbance is an essential one, as operation at high chart speed throws the chart out of time, and resetting it to the proper time insures that a succeeding disturbance will be recorded at the proper hour of the day. The spring motor has sufficient capacity to record four or five successive disturbances without requiring re-winding. This, it is stated, has been found in practical operation to be sufficient.

Long Range Floodlight

A new 24-in. diameter Golden Glow floodlighting projector has been placed on the market by the Electric Service Supplies Co., Philadelphia, Pa. This new projector is known as type FLA-2430 and is to meet service condition such as imposed where space for tower location is available only at either end of the area to be floodlighted. This new unit projects a long-range beam of high intensity.

Type FLA-2430 floodlighting projectors consist of cast aluminum alloy case, approximately $\frac{3}{16}$ in. thick, equipped with hinged rear door made of the same material and in which a 24-in. diameter "Golden Glow" or crystal mirror glass reflector is flexibly mounted. This construction provides easy access to the reflector for relamping or cleaning without disturbing the lamp or its focusing, or the directional training of the floodlight. The focusing device is fitted with a Mogul socket.

The apparatus is adapted for use with standard 1,000 to 1,500-watt type "C" Mazda lamps with the PS-52 bulb for regular floodlighting or the 1,000-watt type "C" Mazda lamps with the G-40 bulb for highly concentrated long-range work. The entire unit is mounted on a swivel trunnion allowing for directing the beam of light in any direction and with provision for locking firmly in position.

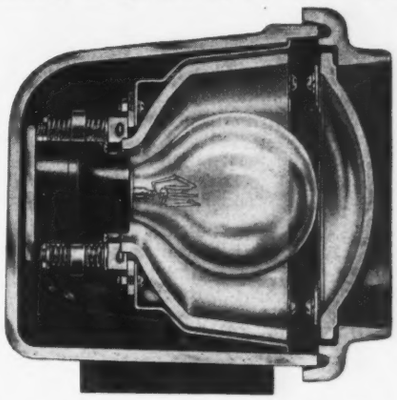
An Automatic Sump Pump

The new automatic sump pump manufactured by the Buffalo Steam Pump Co., Buffalo, N. Y., and used for draining pits, cellars, and excavations, is said to offer five particular advantages: (1) It is easily installed, being a self-contained unit which upon arrival needs only to be uncrated and connected to the electric current supply; (2) the motor shaft and pump are entirely inclosed and positively protected from action of sump water; (3) all parts are easily accessible; (4) ball-bearing thrust is used to carry the weight of the moving parts, and is adjustable to conditions of alignment; (5) oil in place of grease is used to lubricate the thrust, since it is claimed to be far superior for the intermittent use to which the bearings are subjected.

New Headlight Using "Pyrex" Lens Decreases Breakage

In announcing its new Imperial type MB headlight, the Ohio Brass Co., Mansfield, Ohio, believes it has made a decided improvement in its product. This type incorporates features which the company states have made its other styles popular, besides being smaller, more compact and having greater strength.

Pyrex glass is used for the lens and is protected by a guard which makes the usual grids unnecessary. The reflector, though but 5½ in. in diameter



An improved locomotive headlight

according to the manufacturer, gives ample light both at a distance and near the locomotive. The reflector is made of silvered Pyrex glass.

New Pinion Puller Is Light, Quick, and Safe

Speed, light weight and safety are claimed by the Duff Mfg. Co., Pittsburgh, Pa., for a new pinion puller that this firm has just announced.

This pinion puller is quickly attached and a few strokes of the lever bring the device into full tension and a further operation removes the pinion. Three sizes are available for various sizes of pinions, pulleys and flywheels. The housing and the jaws are made of case-hardened steel, and ball bearings are used throughout. According to the manufacturer a uniform force is exerted around the entire circumference of the pulley.

Catalogs

Ventilation—The Coppus Engineering Corporation, Worcester, Mass., in its Bulletin 121, just received, describes compressed-air driven (Vano and Ventair) blowers and exhausters for mine ventilation.

Rock Drills—Bulletin 851 of the Chicago Pneumatic Tool Co., 6 East 44th St., New York, describes the CP-5 drifter. This machine is offered as a fully developed device suitable for practically all mining, quarrying, and contracting work requiring a drill of this type. Its weight, fully equipped, is 118 lb. Advantages claimed for it besides this are its high drilling speed, ease of operation, durability, and dependability.

Market and Financial News

U. S. Smelting Earnings Decline Slightly During Last Year

Surplus of $1,000,000 Expected—Better Metallurgy Offsets Lower Metal Prices in Utah

Consolidated earnings of United States Smelting, Refining & Mining Co. for eleven months ended Nov. 30 amounted to $5,614,437 after interest and reserves for taxes. This compares with net on same basis of $5,998,677 in corresponding months of 1925.

After the period's dividend on preferred stock, final net for 351,117 shares of common amounted to $1,762,221, or $5.01 per share, against $5.56 a share earned on the common in 1925.

In a review of the situation officials estimate that in completing the profit and loss account for the year, the December earnings and miscellaneous annual adjustments (including adjustment of inventories to cost or market, whichever is lower) will increase the gross earnings now reported to more than $6,500,000, and will increase the net earnings to more than $4,000,000. After providing all dividend requirements for the year, it is estimated a balance of over $1,000,000 will be available for additional reserves, for amortization of property and other purposes, or for addition to surplus.

An official statement says that earnings from the metal mines and reduction works in the United States were substantially the same as in 1925. This result, in view of declining metal markets, was principally due to increased tonnage and better metallurgy resulting from installation of the new flotation mill at Midvale, which started operations in March of 1926.

The output of the coal properties in Utah was 707,079 tons for the eleven months of last year, compared with 789,633 tons for the same period in 1925. This reduction in tonnage, combined with generally unsatisfactory condition in the western coal markets, has served to materially reduce profits from this source as well as from the railway serving the Utah coal fields.

Earnings in Mexico have been maintained throughout the period. The output for this last has averaged 104,000 tons, compared with approximately 100,000 tons for the same period in 1925. This increase in tonnage, together with improvement in the metallurgy, and somewhat better grade of ore has tended to offset the unfavorable silver market and other conditions.

At the Nome fields in Alaska, says the statement, two of the four dredges completed their dredging for this season in October and the remaining two dredges operated until early in December, 2,735,000 cu.yd. being dredged with a gross output of approximately $1,200,000. At the Fairbanks fields in Alaska the construction program is being carried forward with satisfactory progress.

Statistical Notes

Gold Production for the United States is estimated by the Bureau of the Mint for 1926 to be $47,299,000. This is the lowest for any year since 1895, being $2,561,200 less than that of 1925.

Manganese production in the Soviet Union virtually doubled during the Soviet fiscal year ending Sept. 30, 1926. Production was about 25 per cent greater than that of 1913.

Under the first year of operation by the Harriman Georgian Managanese Co. the output of the Tchiatouri fields, in Soviet Georgia, was 772,000 metric tons, as compared with 436,000 in 1924-25, an increase of over 80 per cent. The increase in the Nikopol fields, operated by a Soviet trust, was even greater. Production was 815,000 metric tons as compared with 380,000 metric tons in 1924-25, an increase of 114 per cent.

Exports from Tchiatouri were 472,000 tons and from Nikopol 235,000 tons. It is estimated that about half of the Tchiatouri exports were shipped to the United States.

Anaconda Copper Mining Co. has purchased the outstanding interests not heretofore owned by it in Anselmo Mining Corporation. Since 1920 Anaconda has been a half owner in the Anselmo property, which is a copper-zinc mine in the western part of the Butte camp and employs 200 men. Operating economies are expected to result from the change.

Utah mining dividends for 1926 were the largest for any year except during the war. For the twelve months ending Dec. 31, a total of $15,073,500 in dividends was paid by Utah non-ferrous metal mines. This is the largest sum every disbursed during the sixty-five years of Utah mining, except during 1916, 1917 and 1918. The peak was reached when $29,471,015 was distributed in 1917.

Consolidated Mining and Smelting Co. of Canada, which operates the astonishingly productive Sullivan mine in British Columbia, makes a remarkable showing in the comparative production statistics for 1926 and 1925. The figures for the two years for the last quarters of each year are shown in the accompanying table. The figures do not include in either year lead bullion or zinc concentrates shipped to plants other than those of the company. On the other hand there are included in the figures metal from some custom ores that were purchased by the company.

Refined Copper Stocks in the hands of producers in North and South America increased from 73,856 tons at the end of November to 85,501 tons at the end of December, chiefly owing to a decline in domestic shipments from 74,207 tons to 61,942 in December. This may be attributed to postponed shipments to make year-end inventories as small as possible, and was duplicated in the figures for December, 1925. Exports increased from 46,492 tons in November, to 52,837 tons, a satisfactory showing. The daily rate of production, which increased to 4,211 tons in November, declined to 4,078 tons in December, a step in the right direction, though production continues to be too far above shipments to make for a firm copper market.

Mond Nickel Co. for the year ended April 30, 1926, earned £568,646, including interest and dividends received. After paying general charges and debenture interest, £425,035 was carried to the balance sheet.

Cresson Consolidated Gold Mining and Milling Co., operating in the Cripple Creek district in Colorado, reports net returns for the last quarter of the year as $156,242, from the mining of 29,996 tons of ore. During the year ended Aug. 31, 1926, 98,289 dry tons of ore were shipped, of a gross value of $1,377,849.31, averaging $14.01 per ton; the returns, less transportation and treatment, were $870,125.25, giving the ore a net value of $8.85 per ton. The company received as additional income the sum of $21,707.03 interest in bank deposits, making a grand total of $891,832.28, with total expenses of $614,755.54, resulting in a net gain from operations of $277,076.74. The total cost per ton of ore produced was $6.25. This is a decrease of 18c. per ton over 1925. Production was 98,289 dry tons, with an average return of $9.07 per ton. The entire cost was $6.25 per dry ton, resulting in a net profit of $2.82 per ton. The cost of mining is divided as follows:

General expense	$0.000
Taxes	0.470
Insurance	0.137
Salary officers	0.088
Colorado Springs office	0.097
Mining operations	5.450
Total	$6.250

New Cornelia copper output for December is reported as 6,693,700 lb. compared with 8,455,200 in November and 5,856,500 in December a year ago. Calumet and Arizona, of which New Cornelia is a subsidiary increased its output somewhat, reporting 3,902,000 lb., against 3,666,000 last month.

Production Statistics Consolidated M. & S. Co. of Canada

	Fourth Quarter		Full Year	
	1926	1925	1926	1925
Lead, tons	33,424	30,214	124,996	103,036
Zinc, tons	16,642	12,243	61,798	38,535
Copper, tons	2,309	183	10,561	183
Gold, ounces	11,707	8,219	51,770	20,516
Silver, ounces	1,844,1095	1,966,76	6,913,272	4,704,635

The Market Report

Copper Market Much Better; Lead Also Picks Up

Tin Quiet at Unchanged Prices—Increased Stocks Depress Zinc Prices, but Sales Are Good

New York, Jan. 12, 1927—The feature of the week in the non-ferrous metal trade has been the rehabilitation of the copper market, with good sales both here and abroad, and somewhat higher prices. Lead has also sold in satisfactory volume, regaining its preholiday activity, though prices have not strengthened appreciably since last Thursday, when a reduction was made. The tin market continues quiet, with today's quotations about the same as a week ago. Zinc held steady until yesterday, when it became known that stocks increased by about 7,000 tons during December; whereupon prices declined. Generally speaking, sentiment in the trade is better than a week ago, and it is possible that the long decline in metal prices is in process of being arrested.

Daily Prices of Metals

Jan.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
6	12 90	65.00	67.00	7.65	7 475	6.875–6.925
7	12.875	65.25	67.25	7.65	7.45@7.475	6.90@6.925
8	12.90	65.375	67.50	7.65	7.45@7.475	6.90
10	12.95	65.625	67.625	7.65	7.45@7.475	6 90
11	13 025	64 75	66.75	7.65	7.45@7.475	6.80@6 85
12	13.025	65 00	67.00	7.65	7.475@7.50	6.775
Av.	12.946	65.167	67.188	7.650	7.469	6 869

Average prices for the calendar week ending January 8, 1927, are: Copper, 12.917c.; 99 per cent tin, 65.313c.; Straits, 67.167c.; N. Y. lead, 7.704c.; St. L. lead, 7.538c.; zinc, 6.910c.; and silver, 53.875c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
6	55 1/4	56	62	299 1/2	295	27 9/16	27 1/2	31 7/8	31 15/16
7	55 1/2	56 1/4	62	300	294 7/8	27 11/16	28 1/8	32 1/8	32 3/16
10	55 3/8	56 1/4	62	301 3/4	296	27 3/4	28 1/8	32 1/8	32 3/16
11	55 5/8	56 3/8	62	298 1/2	293 3/4	27 3/4	28 1/16	31 3/4	31 11/16
12	56 1/4	57	62 1/2	299 1/8	293 3/4	27 13/16	28 1/16	31 3/4	31 13/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
6	4.84 7/8	54 1/8	25	84s11 1/2d	10	4 84 3/4	54 1/2	25 3/16	84s11 1/2d
7	4.84 3/4	53 7/8	24 15/16	84s11 1/2d	11	4.84 3/4	55	25 1/2	84s10 1/2d
8	4.84 7/8	53 7/8	25	.....	12	4.84 3/4	54 7/8	25 7/16	84s11 1/2d
					Avg.		54.375		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Copper at 13¼c. Today

Business in copper in the week ending today has been much better, a good tonnage having been sold on every business day, so that the total is the best since the record week of Dec. 8. In fact, with the exception of that week, it has been the best since the week of July 14, a fact that has not been generally realized, because one seller was responsible for over a third of the tonnage, with the rest well distributed among the other agencies. Shipment has been fairly well divided among February, March, and April, with an occasional call for prompt. The Middle West has bought to some extent, but most of the business has been placed with brass and wire mills in the East. The foreign demand has also been much improved, chiefly in Germany and England.

Most of the business in the East on Thursday, Friday, and Saturday was done on a 13¼c., delivered, basis, though, in response to much curiosity, it must be admitted that 13c. even was done for Connecticut delivery on Friday. Some sellers have refused to go below 13¼c. at any time. In the last three days the market has worked its way back to 13¼c., Valley delivery, at which level it is decidedly firm today on big business.

Active Week in Lead

In total volume, sales of lead during the week ending today have been exceedingly good, virtually all of the producers participating in the active business. The American Smelting & Refining Co. reduced its official contract price at New York from 7.80c. to 7.65c., on Jan. 6, but real activity began on Monday, following the receipt of London cables, which recorded some improvement abroad for the second day in succession. Corroding grades seem to be in particular demand, though cable makers and "blue-lead" manufacturers participated in the buying. On Monday and Tuesday sales were made as low as a 7.425c., St. Louis basis, but these were more than offset by business at 7.45c., 7.475c., and a very little at 7.50c. A distinctly better tone is manifest in the market today. It would appear either that buyers had come to the conclusion that the bottom of the market had been reached and that higher prices are in prospect, or else that they needed the lead to meet early requirements in their factories. The fact that the bulk of the buying was for prompt and January delivery is significant in this connection. The present New York price is now on a parity with the lowest price reached during the year, 7.65c. being quoted late in May. The low figure for 1925, incidentally, was 7.75c.

Correction: Owing to incorrect cables the price of London forward lead on Oct. 4, 1926, was given as £31¼ instead of the correct figure—£31⅛. The October average should have been £30.969.

Zinc Slightly Weaker

Zinc sales have been well above the average of recent weeks. The outlook in the steel industry is reported somewhat improved. but galvanizers continue doleful. As expected, the statistics issued yesterday by the American

Zinc Institute showed production in December well above shipments. A decline in shipments is not an unusual occurrence in December, owing to disinclination by consumers to add to inventories at the end of the year. The present stock, 21,887 tons, is not large, but the sharp increase led some sellers to cut 10 to 15 points from the 6.90c. price that prevailed generally up to yesterday, some zinc having sold today as low as 6¾c. The statistics, in tons of 2,000 lb., follow:

Stock, Dec. 1	14,481
Produced	56,884
Shipped	49,478
Stock, Dec. 31	21,887
Shipped from plant for export	3,387
Stored for customers	304
Retorts operating, Dec. 31	88,668

The retorts operating figures showed an increase of 592 for the month.

Tin Up and Down

In a comparatively dull market all week prompt Straits tin climbed to 67.625c. on Monday and following a decline of 65s. in London on Tuesday eased again, the prices today being the same as those of Thursday of last week. There is a premium of about ¼c. for spot metal, and today February is quoted at 65.875c., March 65.50c., and April 65.125c.

Silver 55c.

Silver has again reached the 55c. level after an interval of nearly two months, the strength in the market being occasioned by combined buying on the part of India and China. At the higher rate the tone appears slightly easier, although the future depends upon the attitude of these two countries.

Mexican Dollars (Old Mexican pesos): Jan. 6th, 41¼c.; 7th and 8th, 40⅞c.; 10th, 41¼c.; 11th, 42c.; 12th, 41⅝c.

Exchanges Weaken

Closing cable quotations on Tuesday, Jan. 11, for the principal foreign exchanges were: francs, 3.96¾c.; lire, 4.25c., and marks, 23.72c. Canadian dollars, 11/64 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb. 99 per cent grade, 27c.; 98 per cent grade, 26½@27c. London, £105@£107 per long ton.

Antimony—Per lb., duty paid, New York: Chinese brands, spot, 13@14c.; April prices about ⅜c. less; Cookson's "C" grade, spot, 17½c. Market much more active owing to fear that Chinese troubles will interfere with shipments, so prices have advanced. Needle antimony nominally unchanged at 8c. for lump and 10c. for powdered, but sales of spot white oxide have been made at 16½c., 2c. above last week's quotation.

Bismuth—Per lb., New York, in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., New York, 60c. London, 1s. 10½d.@1s. 11d. for American metal; 1s. 10d. for Australian metal.

Iridium—Per oz., $120@$125 for 98 @99 per cent sponge and powder. Quiet. London, £32½ in iridio-platinum; £17@£20 for sponge and powder. Nominal.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton according to quantity.

Osmium—Per oz., $55@$60. London, £16@£19.

Palladium—Per oz., $58@$62. Pure metal as a constituent of crude platinum, $55@$60 per oz. Weaker. London, £11@£12, nominal.

Platinum — Official price on refined metal, $110 per oz. Open market cash sales of large lots, $104@$105. Pure metal as a constituent of crude platinum, $102. Demand from jewelers has improved somewhat, but price is no higher.

London, £23 per oz. for refined and £20½ for crude. Dull.

Quicksilver—Per 75-lb. flask, $100@$102 for spot depending upon quantity. San Francisco wires $99.33, steady. London £17½@£17½.

Rhodium—Per oz., $55@$60; London, £10.

Ruthenium—Per oz., $45@$50; London, £7½.

The prices of **Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Radium, Selenium, Tellurium, Thallium, Tungsten,** and **Zircon** are unchanged from the issue of Jan. 8.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c. Chemical grades unchanged from Jan. 8 issue.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $10.75@$11; Western scheelite,$11.25@$11.50. Market dull.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and **Vanadium Ores** are unchanged from quotations in the Jan. 8 issue.

Zinc Blende and Lead Ore Both Lower

Joplin, Mo., Jan. 8, 1927

Blende		
High		$50.00
Premium blende, basis 60 per cent zinc	$46.00@	47.00
Prime Western, basis 60 per cent zinc		45.00
Fines and slimes, 60 per cent zinc	44.00@	40.00
Average settling price, all zinc		45.46
Galena		
High		$101.10
Basis 80 per cent lead		95.00
Average settling price, all lead		100.20

Shipments for the week: Blende, 12,385; calamine, 52; lead, 2,364 tons. Value, all ores the week, $802,760.

On account of cleaning as much concentrate from the bins as practicable prior to tax asessments on Jan. 1, production was lowered to 15,000 tons. That is the tax date in Oklahoma, though March 31 is the date in Kansas, and in Missouri it is June 1. Unsold stock in the bins is around 10,000 tons, largely in Kansas.

Lead stocks have been materially lowered, a large tonnage selling prior to the drop below the $100 basis, now practically all loaded and shipped.

Platteville, Wis., Jan. 8, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$48.75
Lead Ore	
Lead, basis 80 per cent lead	$100.00

Shipments for the week: Blende, 1,664 tons; lead, 60 tons. Shipments for the year: Blende, 1,664; lead, 60 tons. Shipments for the week to separating plants, 2,507 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the Jan. 8 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3½ per lb. Quiet. London, £16½ per long ton for 99 per cent Cornish white.

Calcium Molybdate, Copper Sulphate, Sodium Nitrate, Sodium Sulphate (Salt Cake), and **Zinc Oxide** are unchanged from prices in the Jan. 8 issue.

Ferro-Alloys

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $36@$37, f.o.b. furnace; 16@19 per cent, $34@$35.

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from prices in the Jan. 8 issue.

Metal Products

Rolled Copper—Sheets, 22c.; wire, 15½c.; f.o.b. mill.

Lead Sheets—Full rolled, 11½c. per lb.; clipped, 11⅝c.

Nickel Silver—28⅜c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 17⅜c. per lb.; rods, 16½c.

Zinc Sheets—11c. per lb., f.o.b. mill.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and **Zirkite** are unchanged from quotations in the Jan. 8 issue.

Steel and Pig Iron Quiet—Coke Firm

Pittsburgh, Jan. 11, 1927

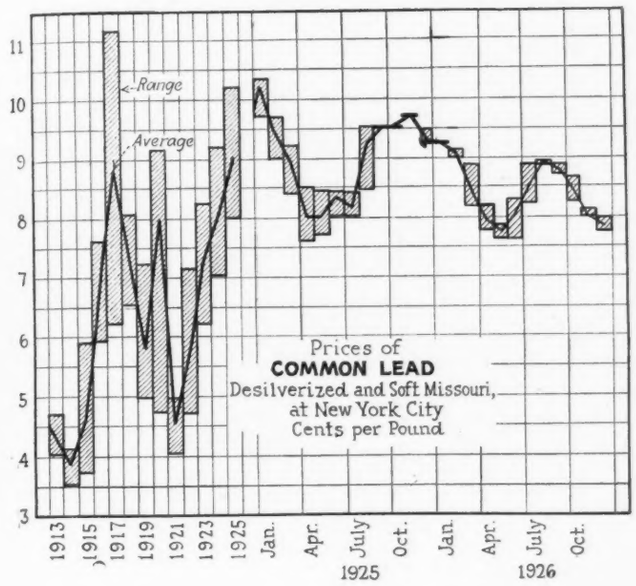
Buying activity in steel has not opened up, since Jan. 1, to the extent that would ordinarily be expected.

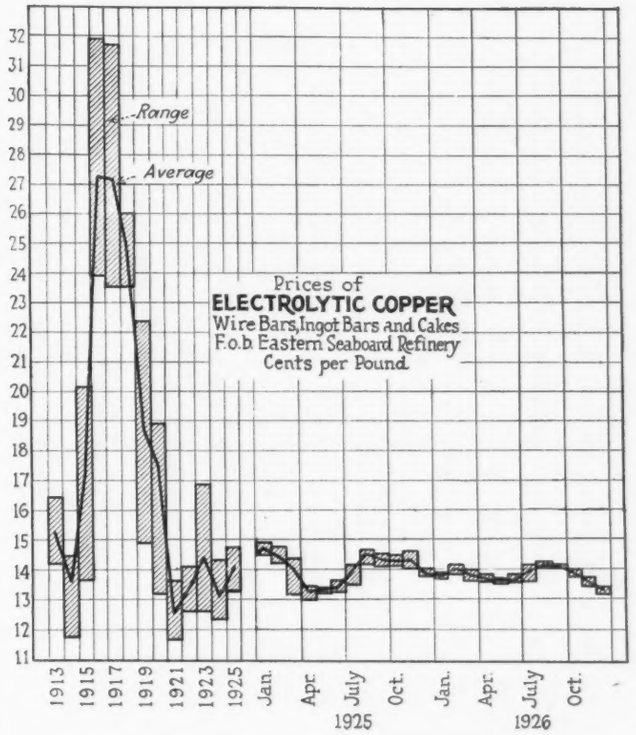
Steel prices show no change, except that sheets in general are weaker still, and automobile sheets are off $2 a ton, at 4.15c.

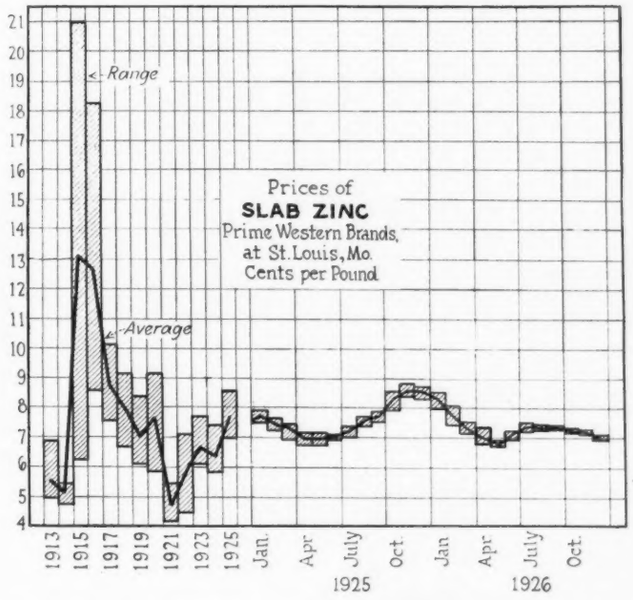
Pig Iron—The market remains quiet. Bessemer, $19.50; basic, $18.50; foundry, $18.50@$19, f.o.b. Valley furnaces.

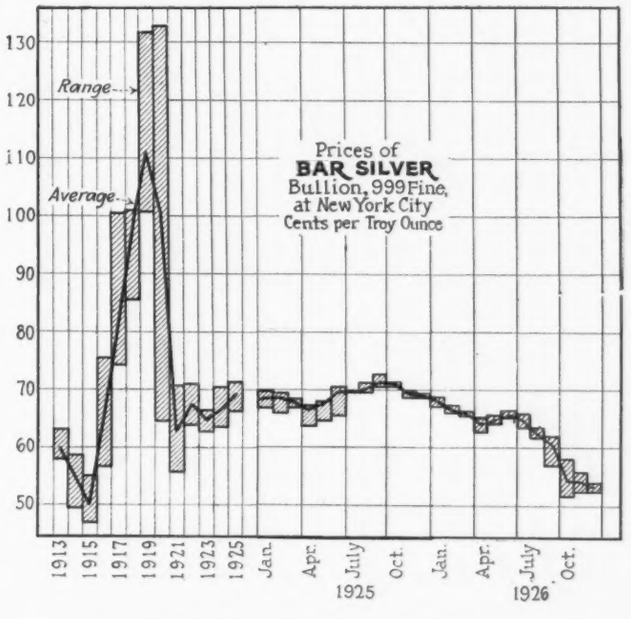
Connellsville Coke—Ranges remain at $3.50@$4 for furnace and $4.75@$5.25 for foundry.

Metal Price Curves

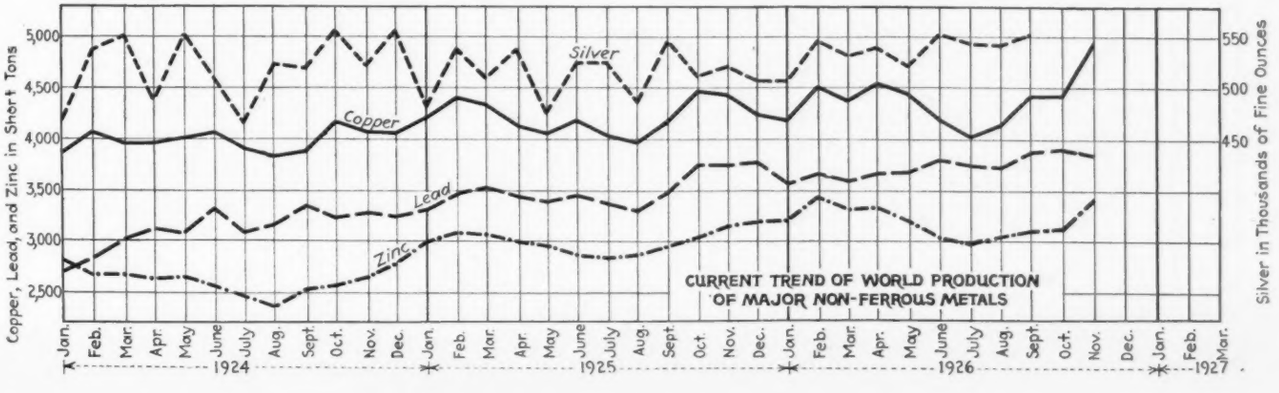



Range
Average
Prices of
ELECTROLYTIC COPPER
Wire Bars, Ingot Bars and Cakes
F.o.b. Eastern Seaboard Refinery
Cents per Pound
1913 1915 1917 1919 1921 1923 1925 Jan. Apr. July Oct. Jan. Apr. July Oct.
1925 1926





THE curves below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output, according to latest estimates of the American Bureau of Metal Statistics. The figures represent countries that produced in 1924 and 1925 about 97 per cent of the world's output of copper; 78 per cent of the lead; 87.5 per cent of the zinc; and 81 per cent of the silver.


Silver
Copper
Lead
Zinc
CURRENT TREND OF WORLD PRODUCTION
OF MAJOR NON-FERROUS METALS
Copper, Lead, and Zinc in Short Tons
Silver in Thousands of Fine Ounces
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1924 1925 1926 1927

Review of Current Statistics

By A. B. Parsons
Assistant Editor

HIGHER PRODUCTION RATES and lower prices for copper stand out as the features of the non-ferrous metal industries in December. The estimated rate of world production in November, the latest month for which data are available, was about 5,080 tons of metal per day. This is equivalent to 3,708,000,000 lb. per year, compared with a probable actual production of 3,282,000,000 lb. for 1926, the highest output in history.

It is not impossible that some unusual factors in the November statistics, not apparent on the surface, operated to swell the total. Some decline may eventuate during the early months of 1927. However, reports of expansion of production by many of the big companies in the United States, Chile, and Peru have been heard for some months, and the figures for November certainly lend support to the accuracy of these reports; and, at the same time, the reports tend to diminish the possibility that important peculiarities enter into the November statistics.

Although the average price for copper in December was only about ¼c. under that for November, the price on Jan. 1 was fully ¾c. lower than that on Dec. 1. In other words the drop in December was sharp and rapid in the latter half of the month after the statistics were made public. Doubtless the important producers expected a decline in price when they launched their policy of increasing production; but it is a question how far they anticipated the decline would go. As this is written the tone of the market seems to have improved somewhat, but whether the real bottom has been reached remains to be seen.

December Average Metal Prices

In cents

Metal	1924	1925	1926	Decline, Per Cent 1925–1926
Copper, lb.	14.26	13.86	13.30	4.0
Lead, lb.	9.20	9.31	7.85	15.6
Silver, oz.	68.09	68.89	53.46	22.4
Zinc, lb.	7.37	8.57	7.02	18.1
Aluminum, lb.	27.00	28.00	26.93	3.8
Tin, lb.	56.24	62.93	68.51 (a)	8.9
Nickel, lb.	29.00	35.00	35.00	0.0

(a) Increase.

But copper is not alone in giving a poor account of itself, marketwise, during December. Each of the metals in the group, with the single exception of nickel—which remained unchanged—declined. Even aluminum is easier, as a result of offerings at lower levels by producers outside the "trust." The graph on the opposite page shows that the *E. & M. J.* Weighted Index of Non-Ferrous Metals, at 102.31, is lower than it has been at any time during the last two years.

Both one and two years ago prices were at crests that were followed by declines during the first four or five months of the next year. However, seasonal trends in metal prices have never been consistently uniform, and an upturn may be at hand. The accompanying tables of average December prices for the last three years is interesting.

Silver is the most important factor in the decline of the Index Number, followed by lead, zinc, and copper in the order named.

Non-metallic prices were quotably unchanged during the month, and the Weighted Index remains well above 104, only a little below the high figure established in September.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	134.38
1926	107.74

	1925	1926
June	107.19	106.68
July	108.81	109.08
August	113.61	110.22
September	114.66	109.27
October	115.64	106.20
November	116.69	104.21
December	116.99	102.31

Shares in the companies included in the mining - smelting - manufacturing group continued the recovery that started in November. American Smelting & Refining reached about $148, and was the chief contributor to the substantial gain made by the group. With the dividend rate increased from $7 to $8 per share, with current earnings close to $20 per share of common stock, and with $32,000,000 surplus on hand the Smelting Company is in an excellent financial position.

National Lead continued on its upward course. Though the company has some interests in tin and lead mining enterprises, its business is primarily manufacturing, and earnings are dependent more on general industrial conditions than upon metal prices. The American Metal Co. was the only one in the group to lose appreciable ground. Earnings during the first nine months of the year were barely sufficient to meet dividend requirements at the $4 annual rate, and a reduction to $3 is not unlikely. However, the company has been doing a lot of development and construction work in Mexico and New Mexico, and revenue from these ventures should be forthcoming soon. The accompanying table shows the approximate stock-market position of the seven companies at the close of each of the last three years.

Chile Only Copper Stock to Advance

In the copper group a small net increase was due solely to appreciation in Chile Copper shares. All of the others declined with the exception of Miami and United Verde Extension, which showed no change during December. On account of its huge number of outstanding shares (4,391,330), the improvement in Chile of about $2.375 per share was sufficient to offset the losses in the others. The reason for the upward movement in Chile doubtless is the action of the company in calling the $35,000,000 in 6 per cent convertible bonds, to be replaced by the new issue of 5 per cent non-convertible debentures. The 6 per cent bonds are redeemable at $110, and have been called for April 1, 1927, subject to conversion at $35 per share prior to March 20. Chile's recently issued financial statement showed decreased earnings, but Chile figures income on the basis of sales rather than on tonnage produced. During the third quarter about 8,000,000 lb. of unsold copper apparently was produced, and, as a consequence, the report has a pessimistic flavor on the face of the figures that is not entirely warranted.

The silver-lead shares in the miscellaneous group of thirteen fared badly, Hecla, Utah-Apex, Silver King Coalition, and Tintic Standard all declining appreciably. On the other hand, the gold stocks, Cresson, Lake Shore, Homestake, and particularly Hollinger, climbed. St. Joseph Lead also gained, as did Howe Sound and Federal M. & S.

Increased production and stocks are revealed by the latest available "tonnage" statistics, not only for copper, as already commented on, but for zinc and lead. The curve for world production of silver on page 117 has not been brought up to date because of the lack of figures for Mexico, the largest contributor. It is not likely in view of increases in the other countries that the figures, when available, will show a decline for October and November.

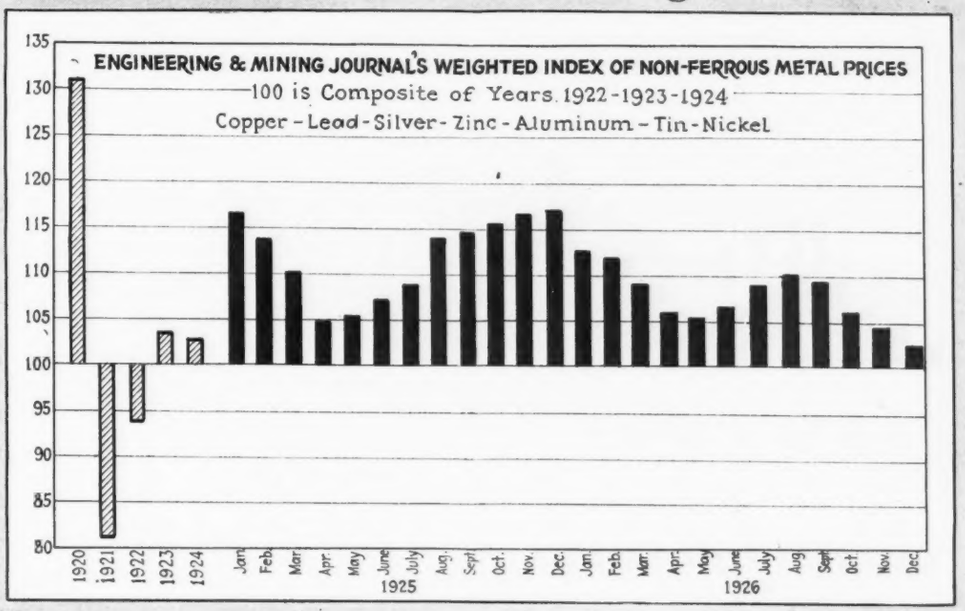
The estimated world rate for lead production is slightly lower for November, although there is an increase in the smelter production for the United States and Mexico. Zinc production in the world and production and stocks in the United States swelled in November, and the figures for the United States, received since the curve on the opposite page were prepared, show a continuation of this trend.

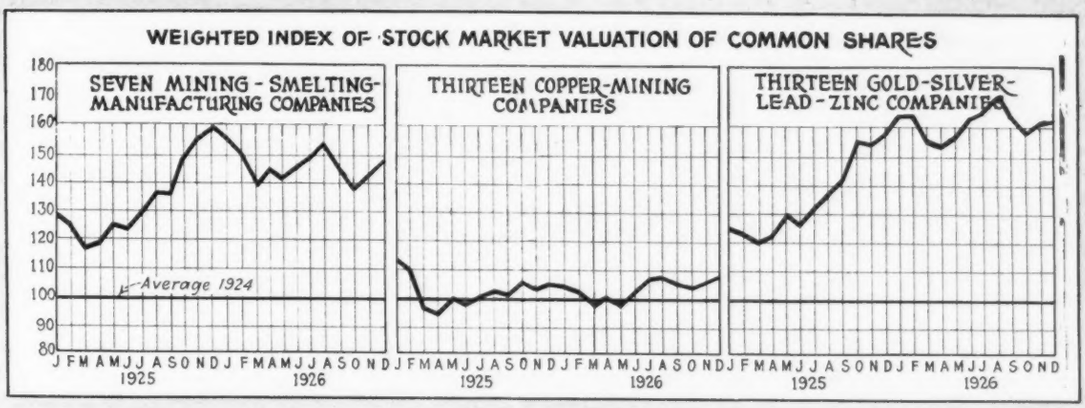
Closing Prices of Common Shares

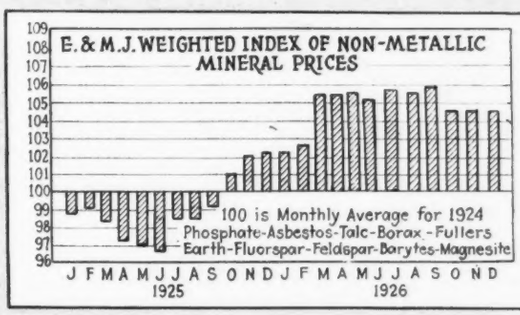
Company	1924	1925	1926
Anaconda	47⅞	49⅞	49
A. S. & R.	99⅜	142½	147⅜
New Jersey Zinc	195	207½	187½
International Nickel	26⅞	45	37⅜
National Lead	160	167½	173¾
U. S. Smelting	40¾	49¼	35⅛
American Metal	52¼	54½	42½

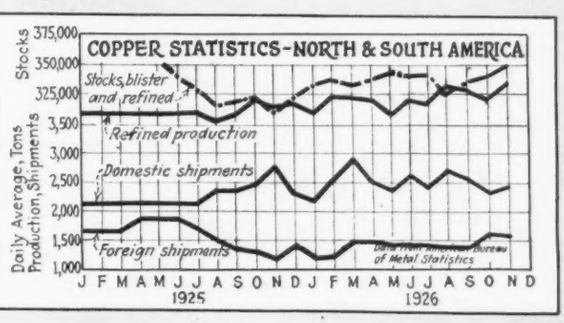
That all stocks remain comparatively low (lower than is safe, say producers) is an evidence of the capacity of domestic industry to absorb a constantly increasing quantity of metals; that, with continued expansion in output, prices are somewhat lower should not occasion surprise. It is well also to recall that the level of the general commodity index declined during the year by a figure between 6 and 7 per cent.

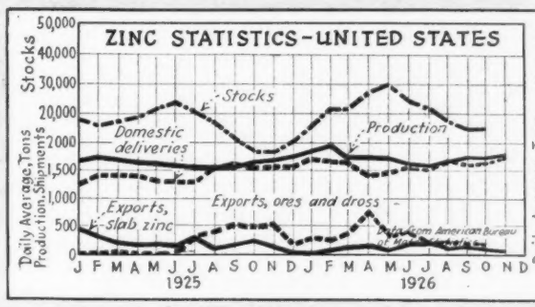
E.&M.J. Statistics of the Mining Industries

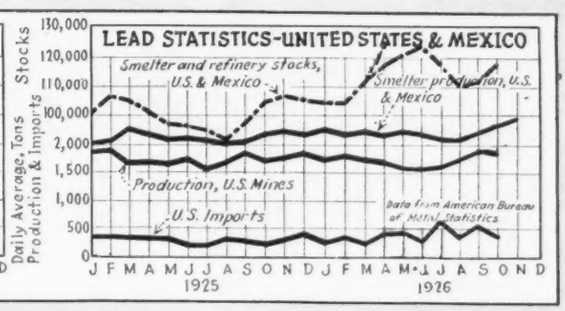












Mining Stocks—Week Ended January 8, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	48⅜	47⅛	48⅛	Ja. 15, Fe. 21	Q 0.75
Arcadian Consol.	Boston	*80½	*80	*80	.....	.....
Ariz. Com'l	Boston	10¼	9⅝	9⅞	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb	2	1⅝	1⅝	.....	.....
Calumet & Arizona	New York	67	65⅝	66½	De. 3, De. 20	Q 1.50
Calumet & Hecla	Boston	15	14⅝	14⅞	No.30, De.15	0.50
Cerro de Pasco	New York	62½	61⅛	62	Ja.13,Fe 1, Q	1.00
Chile Copper	New York	34⅞	34⅜	34⅝	De.1,De.27, Q	0.62½
Chino	New York	23⅛	22⅛	22⅛	.....	.....
Con. Coppermines	N. Y. Curb	3	2⅞	2⅞	.....	.....
Copper Range	Boston	14¼	13	13	May, 1926	1.00
Crystal Copper	Boston Curb	*30	*29	*29	.....	.....
East Butte	Boston	2¼	2⅛	2⅛	Dec., 1919	0.50
First National	Boston Curb	*8	*8	*8	Feb., 1919	0.15
Franklin	Boston	*20	*20	*20	.....	.....
Granby Consol.	New York	35	33⅞	33⅝	May, 1919	1.25
Greene-Cananea	New York	31⅛	30¼	30⅜	Nov., 1920	0.50
Hancock	Boston	...	...	*37	.....	.....
Howe Sound	New York	40	38⅞	38⅞	Oc.1, Oc.15	Q 1.00
Inspiration Consl.	New York	25⅛	24⅜	24⅞	De.16, Ja.3, Q	0.50
Iron Cap	Boston Curb	3½	2⅝	3⅛	.....	.....
Isle Royale	Boston	10⅛	10	10	No. 30, De. 15	0.50
Jerome Verde Dev.	N. Y. Curb	*30	*30	*30	.....	.....
Kennecott	New York	62¼	61⅛	61⅜	De. 3, Ja. 2	Q 1.25
Lake Copper	Boston	*99	*80	*80	June, 1925	0.50
Magma Copper	New York	35⅜	34½	34⅝	Dec. 1, Ja. 15,Q	0.75
Mason Valley	N. Y. Curb	2⅛	1⅞	2⅛	.....	.....
Mass Consolidated	Boston	*35	*30	*30	Nov., 1917	1.00
Miami Copper	New York	16⅛	15⅞	15⅞	Fe 1, Fe. 15	Q 0.37½
Mohawk	Boston	39⅛	39	39	Oc.30, De 1	Q 2.00
Mother Lode Coa.	New York	4⅜	4⅛	4⅛	De.10,De.31	SA 0.37½
Nevada Consol.	New York	15	14⅜	14⅜	De.15, De.31	Q 0.37½
New Cornelia	Boston	22⅜	22¼	22¼	No.5, No.22	Q 0.50
Noranda	N. Y. Curb	24	23⅜	23⅜	.....	.....
North Butte	Boston	3⅜	3	3⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*45	*45	*45	Se. 1, Se. 15	0.03
Old Dominion	Boston	14½	13½	14⅜	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†132	†128	...	De.24, Ja.3	Q 1.50
Quincy	Boston	17½	16	16½	Mar., 1920	1.00
Ray Consolidated	New York	15⅝	15⅛	15⅛	Ap.20, Ap.30	0.25
St. Mary's Min. Ld.	Boston	25⅛	24⅛	24⅜	May, 1926	2.00
Seneca Copper	New York	3¼	2⅞	3⅛	.....	.....
Shannon	Boston	*25	*20	*25	Nov., 1917	0.25
Shattuck-Denn	Boston Curb	5⅛	5⅛	5⅛	.....	.....
Superior & Boston	Boston	*30	*30	*30	.....	.....
Tenn. C. & C.	New York	11⅛	10⅞	11⅛	No.30, De.15, Q	0.25
United Verde Ex.	N. Y. Curb	24⅛	23⅛	23⅛	Ja. 6, Fe. 1	0.75
Utah Copper	New York	113½	113⅛	113⅛	De.15,De.31	Q 1.50
Utah Metal & T.	Boston	1⅛	1	1⅛	Dec., 1917	0.30
Victoria	Boston	...	...	*75	.....	.....
Walker Mining	Salt Lake	*76	*72	*72	.....	.....
NICKEL-COPPER						
Internat. Nickel	New York	42¼	38⅛	42⅛	De.16, De.31,	Q 0.50
Internat. Nickel, pfd.	New York	....	....	104⅛	Ja. 13, Fe. 1,	Q 1.50
LEAD						
Gladstone Mtn.	Spokane	*28	*27½	*27½	Dec. 10, 1926	Q 0.005
National Lead	New York	167	165⅛	167	De.10, De.31	Q 2.00
National Lead pfd.	New York	118¾	118	118⅜	No.19,De.15	Q 1.75
St. Joseph Lead	New York	42⅛	41⅛	42⅛	Ma.10, 21	XQ 0.75
ZINC						
Am. Z. L. & S.	New York	10	8⅛	9⅛	May, 1917	1.00
Am. Z. L. & S, pfd.	New York	48⅛	42	48	Nov., 1920	1.50
Butte C. & Z.	New York	4⅛	4⅛	4⅛	De.9, De.24	0.50
Butte & Superior	New York	11⅛	10⅛	11⅛	De.9, De.24	Q 0.50
Callahan Zn-Ld	New York	1⅜	1⅛	1⅛	Dec., 1920	0.50
Eagle-Picher	Cincinnati	28⅛	27⅛	27⅞	No.15, De.1	Q 0.40
Eagle-Picher, pfd.	Cincinnati	...	...	100	De.31, Ja.15	Q 1.50
New Jersey Zn.	N. Y. Curb	193	191	193	No.20, De.10	X 2.00
United Zinc	N. Y. Curb	...	...	55	.....	.....
Yellow Pine	Los Angeles	*25	*18	*25	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	1½	1⅛	1⅛	.....	.....
Argonaut	Toronto	*55	*51	*52	.....	.....
Barry-Hollinger	Toronto	*87	*84½	*85	.....	.....
Carson Hill	Boston	*10	*10	*10	.....	.....
Consol. W. Dome L.	Toronto	*18	*16½	*17	.....	.....
Cresson Consol. G.	N. Y. Curb	2⅛	2⅛	2⅛	De.31, Ja.10	Q 0.10
Crown Reserve	Toronto	*11⅞	*10	*10	Jan., 1917	0.05
Dome Mines	New York	11⅛	10⅛	10⅜	De.31,Ja.30,	Q 0.50
Golden Center	N. Y. Curb	1⅜	1⅛	1⅛	.....	.....
Golden Cycle	Colo Springs	†1.77	†1.76	....	No.30, De.10	Q 0.04
Hollinger Consol.	Toronto	20.95	20.40	20.60	De.13, De.31	F 0.10
Homestake Mining	New York	62	62	62	Ja.20,Ja.25	MX 1.50
Kirkland Lake	Toronto	1.00	*89	*93	.....	.....
Lake Shore	Toronto	16.00	15.40	16.00	De.2,De.15	X 0.20
McIntyre-Porcupine	New York	26¾	25½	26⅝	No.1, De.1	Q 0.25
Newray	Toronto	...	...	*33	.....	.....
Night Hawk Pen.	Toronto	*8⅛	*5⅛	*5⅛	.....	.....
Portland	Colo Springs	*56	*53	....	Ja.6, Ja.15, '27	Q 0.02
Rand Mines	New York	....	....	9⅛	Au 23-30	Am.Sh. 1.52
Teck-Hughes	Toronto	6.00	5.37	5.93	Ja.31, Fe. 1	Q 0.05
Tom Reed	Los Angeles	*57	*50	*50	Dec., 1926	0.02
Tough-Oakes	Toronto	*62	*57	*59½	.....	.....
United Eastern	N. Y. Curb	*53	*53	*53	July, 1924	0.05
Vipond Cons.	Toronto	1.75	1.60	1.55	.....	.....
Wright-Hargreaves	Toronto	9.90	9.40	9.90	Ja15,Fe.1	QX 0.15
Yukon-Alaska Trust	N. Y. Curb	....	....	20⅛	.....	.....
GOLD AND SILVER						
Carnegie Metals	Boston	11⅜	11⅛	11⅜	.....	.....
Con. Cortez	N. Y. Curb	*12	*8	*8	.....	.....
Con. Virginia	San Francisco	*7⅛	*7⅛	*7⅛	.....	.....
Continental Mines	N. Y. Curb	*16	*15	*15	.....	.....
Dolores Esperanza	N. Y. Curb	...	...	*50	July, 1923	0.05
Premier Gold	N. Y. Curb	...	...	1⅞	De.17, Ja.4	Q 0.08
San Rafael	San Francisco	...	...	*28	.....	.....
Tonopah Belmont	N. Y. Curb	2⅛	2⅛	2⅛	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*25	*25	*25	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	3⅛	3⅛	3⅛	Se.30, Oc.21	SA 0.07½
West End Consol.	N. Y. Curb	...	...	*8	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	...	...	*40	June, 1918	0.02

Stock	Exch.	High	Low	Last		Last Div.
SILVER						
Beaver Consol.	Toronto	*75	*71	*74½	May. 1926	0.03
Canadian Lorrain	Toronto	*58	*51	*53	.....	.....
Castle-Trethewey	Toronto	1.08	1.02	1.02	.....	.....
Conagas	Toronto	4.40	4.25	4.35	May, 1924	0.12½
Keeley	Toronto	1.53	1.50	1.52	Se. 1, Se.15	SA 0.12
Kerr Lake	N. Y. Curb	*80	*80	*80	Oc. 1, Oc.15	SA 0.12½
La Rose	Toronto	*11	*10	*10	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto	...	...	*55	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*13	*11½	*13	Oct., 1920	0.03
Mining Corp. Can.	Toronto	3.35	3.05	3.30	De.30, Ja.15	0.12½
Nipissing	N. Y. Curb	9⅜	8	9⅛	De.31, Ja.20	Q 0.15
Temiskaming	Toronto	*5⅜	*5⅛	*5⅛	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	5⅛	4⅞	4⅞	De.18,Ja.5,	QX 0.15
Bingham Mines	Boston	38⅛	30	38	De.30, Ja.5	Q 1.00
Cardiff M. & M.	Salt Lake	*50	*44	*44	Nov., 1924	0.10
Chief Consol.	Salt Lake	2.87½	2.87½	2.87½	Oc.10, No.1	Q 0.10
Consti'n Mng.&Mill'g	Spokane	*45	*25	*28	.....	.....
Emma Silver	Salt Lake	*1⅛	*1⅛	...	.....	.....
Erupcion	Boston Curb	1⅛	1⅛	1⅛	De.18, Ja.3,	Q 0.10
Federal M. & S.	New York	...	...	88	.....	.....
Federal M. & S., pfd.	New York	76⅛	75⅜	76⅛	No.24, De.15	Q 1.75
Hawthorne Mines	N. Y. Curb	*11	*9	*9	.....	.....
Hecla Mining	N. Y. Curb	*15⅜	*14⅛	*14⅛	No.15,De.15	Q 0.50
Highland-Surprise	Spokane	*16½	*15	*15	.....	.....
Iron King Mining	Salt Lake	...	...	*20	.....	.....
Keystone Mining	Salt Lake	...	...	*30	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16⅜	*16⅛	*16⅛	.....	.....
Lucky Tiger-Com.	Kansas City	†6.60	†6.00	...	Dec. 20, 1926	0.12
Mammoth Mining	Salt Lake	2.70	2.60	2.60	De.17, De.23,Q	0.25
Marsh Mines	Spokane	*2	*2	*2	.....	.....
Park Utah	New York	6.00	5.95	6.00	De.15, Ja.2	Q 0.15
Plutus Mining	Salt Lake	2.00	1.97½	2.00	Oct. 15,	Q 0.15
Prince Cons.	Salt Lake	...	...	*1⅜	.....	.....
Silver King Coal	Salt Lake	7.85	7.75	7.75	De. 16, Ja.3	0.25
Silversmith	Spokane	*28⅛	*26½	*27⅜	Oc.1, Oc.10	Q 0.02
Strattons Mines	Spokane	*30	*25	*27	.....	.....
Sunshine M. Co.	Spokane	*40	*37	*39½	.....	.....
Tamarack-Custer	Spokane	*44	*39	*44	Sept., 1924	0.25
Tintic Standard	Salt Lake	10.75	10.62½	10.75	De.11, Ja.3	0.30
Utah-Apex	Boston	6⅛	5⅞	6⅛	Oc.3, Oc.15	Q 0.25
IRON						
Bethlehem Steel	New York	47⅛	46½	47⅛	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	77	70	75	Oct., 1926	1.00
Colorado Fuel & Iron	New York	45⅜	42⅜	44⅜	May, 1921	0.75
Gt. North'n Iron Ore	New York	19⅜	19⅛	19⅜	Dec.6, Dec.28	0.75
Inland Steel	New York	43⅛	42	42	No.15, De.1	Q 0.62½
Mesabi Iron	N. Y. Curb	...	...	95	.....	.....
Replogle Steel	New York	13	11⅛	13	.....	.....
Republic I. & S.	New York	58⅛	56⅛	58⅛	No.15, De.1	Q 1.00
Republic I. & S. pfd.	New York	97	96⅛	97	De.15, Ja.2	Q 1.75
Sloss-Sheffield S. & I.	New York	130⅛	128	130	De.10, De.20	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	....	....	107	De.20, Ja.3	Q 1.75
U. S. Steel	New York	130⅛	130	130	De.1, De.30	Q 1.75
U. S. Steel pfd.	New York	115⅜	112⅛	115	No.2, No.29,	Q 1.75
Virginia I. C. & C.	New York	51	49⅛	49⅛	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York	...	...	80⅛	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York	...	...	32⅜	Ju.16, Ju.17	1.70
So. Am. Gold & P.	N. Y. Curb	3⅜	3⅛	3⅜	.....	.....
Alum.Co.of Amer.	N.Y.Curb	72	71	72	.....	.....
Alum. Co. of Amer pf.	N.Y.Curb	102	101⅛	101⅜	De.15, Ja.15	Q 1.50
Vanadium Corp.	New York	39⅜	39	39	De.1, De.15,	X1.00
Patino M. & E.	N. Y. Curb	25⅛	25	25⅛	Nov. 5, 1926	5 sh.
ASBESTOS						
Asbestos Corp.	Montreal	24	23⅛	24	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	85	83	84	De.31, Ja.15,	Q 1.75
SULPHUR						
Freeport Texas	New York	36⅜	34	36⅜	Ja.15, Fe.1	Q 0.50
Texas Gulf, new	New York	50⅜	49	50⅜	De.1, De.15,	Q 1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	43⅜	42⅜	43⅛	No.19, De. 1,	Q 1.00
Amer. Metal pfd.	New York	108	108	108	No.20, De.1	Q 1.75
Amer. Sm. & Ref.	New York	143⅛	138⅛	139⅞	Ja.14, Fe.1,	Q 2.00
Amer. Sm.&Ref.pfd.	New York	121⅞	120⅛	121	Fe.4, Ma.1,	Q 1.75
Consol. M. & S.	Montreal	2.55	2.51½	2.54	De.31, Ja.15	X6.25
Federated Metals	N. Y. Curb	...	...	12⅛	.....	.....
Newmont Mining	N. Y. Curb	67⅛	67⅛	67⅜	De.31, Ja.17,	0.60
U. S. Sm. R. & M.	New York	36⅞	34⅛	34⅛	Ja.6, Ja.15,	Q 0.87½
U. S. Sm. R.&M.pfd.	New York	47¼	46⅛	47	Ja.6, Ja.15,	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Henry Sachs, Colorado Springs, Colo.

LONDON QUOTATIONS—WEEK ENDED DEC. 28, 1926

Name	High	Low	Last	Date	Last Div. Amount
Aramayo Mines (25 frs.)	75/—	73/9	75/—	Aug. 1926	15 p.c.†
British Platinum (£1)	3/—	2/9	3/—	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/10½	14/—	14/10½	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	7/1½	6/9	6/10½		
Camp Bird (2s)	2/6	2/3	2/3		
El Ore (£1)	4/3	4/—	4/—	Nov. 1924	2½ p.c.*
Esperansa (10s)	—/6	—/1½	—/3		
Frontino & Bolivia (£1)	12/6	12/—	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	8/6	8/—	8/6		
Mexico Mines of El Oro (£1)	21/3	19/—	21/3	Dec. 1926	3½ p.c.*
N'Changa Copper Mining	13/3	13/9	16/3		
Oroville Dredging (£1)	4/1½	3/9	3/9	Dec. 1923	3½ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	87/6	80/—	85/—		
St. John del Rey (£1)	9/1½	9/—	9/—	June 1925	6½ p.c.
San Francisco Mines (10s)	31/9	31/3	31/9	Jan. 1927	25s. 6d.
Santa Gertrudis (£1)	14/4½	14/—	14/1½	Jan. 1927	3½ p.c.
Selukwe (2s. 6d.)	12/3	11/1½	12/—	April 1917	6½ p.c.
S. Amer. Copper (2s.)	3/6	3/1½	3/6	Nov. 1917	75 p.c.
Tanganyika (£1)	45/—	41/3	43/9	Aug. 1926	7½ p.c.
Tomboy (£1)	3/3	3/1½	3/3	July 1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	8.500	8.400	8.500	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation